ELECTRICAL REVIEW

[ILLUSTRATED.]

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The Field Electric Motor.

DESCRIPTION AND ILLUSTRATION OF THE LATEST WORK OF STEPHEN D. FIELD.

The new electric motor "Yonkers," invented by Mr. Stephen D. Field, has been brought to this city from Yonkers, N. Y., where it was built, and is now attracting the attention of many passengers on the Thirty-fourth street branch of the New York Elevated road, where it now stands. This particular motor was designed for work on the elevated roads of New York, and marks a new departure in railroading. Numerous attempts have been made to supplant locomotives by a more desirable form of motive power. In Fig. 1 is given a view of the motor and car complete; Figs. 3, 4 and 5, page 2, illustrate the various interesting parts, which will aid our readers in fully comprehending Mr. Field's valuable work. We also give a view of the Eickemeyer dynamo, Fig. 2, which we have heretofore thoroughly described. This particular dynamo is capable of furnishing at 1,000 revolutions, 200 amperes under pressure of 1,200 volts, this being far in excess of the requirements of the motor.

The armature of the motor is 24 in. in diameter and 42 in. long, and is built up of thin disks of soft iron. There are 104 sections in the commutator. The wire is four layers deep, about two miles of No. 7 being used. The armature complete with shaft weighs 600 lbs., and has a resistance of two ohms, and is adapted for an electromotive force of 600 volts. About four miles of No. 4 wire, with a resistance of 2½ ohms, is wound on the field, which has but slightly greater magnetic strength than the armature. The locomotive weighs nine tons, and at its maximum develops 120 horse power. The braking at present is done by hand. The current is taken from the third rail by two wheels, one at each end of the locomotive.

These wheels are built up of brass disks, which press on the rail, not in the direction of its length, but at a bias, like what is known in mechanics as the Chili mill. The wheels wear out very slowly, and perfect contact is assured, no matter what the condition of the rail may be.

The field and armature are in series, and the speed of the motor, and consequently the current, is regulated by a novel form of resistance. A large box, having two sides covered with iron slabs, is filled with acidulated water. This is shown in the interior drawing, Fig. 3. Two slabs of slate are raised or lowered in this liquid by a notched lever. By raising these slabs the current increases from 3 to 170 amperes, a contact cutting out the resistance when the slabs are raised to the fullest extent. There is no gas, and very little heat generated. What there is of the latter will be utilized in winter in heating the cars from radiating coils.

Double cut-out switches enable the circuit to be conveniently broken if desired. The brushes are brought automatically to the non sparking point by a small motor; the direction of the current through the armature of which is changed by a polarized relay which is relatively in the same position as the galvanoscope in a Wheatstone bridge. The armature coils forming the four arms of the bridge as supplementary brushes are in contact midway between the neutral points. The magnets (Fig. 4) are changed in polarity as the brushes become distant from the non-sparking point. The magnet is pulled towards one pole of the magnets *M*, and contact is made at *E* or *F*. *C* is in connection with the circuit to the third rail, *B* with the wheels and return circuit of the rails. *R* is a resistance of 1,000 ohms, *F M* represents the field magnets of the motor which moves the brushes *A* is the armature of the same. The current in the field has a constant direction, but in the armature varies, as *G* is in contact with *E* or *F*. On reversing the current through the car motor the brushes are rapidly changed and turned over so as to point in the direction of the rotation of the armature of the car motor. An improvement over the permanent magnet polarized relay is obtained by substituting an electro-magnet on Eickemeyer's iron-clad plan, embracing a solenoid armature, the trouble from residual magnetism being thus avoided. The points of interest in this system which are new are: Liquid variable resistance, Eickemeyer's winding and construction of armature, mounting of field magnets on the truck, pick-up wheels, brush governor, direct connection of armature with driving wheels.

The dynamo station for the present experimental tests is located at the Manhattan Warehouse, two-thirds of a mile distant.

The motor and car were constructed at the factory of Messrs. Osterheld & Eickemeyer, Yonkers, N. Y. Mr. Field has been assisted in his work by Mr. David E. Lain, assistant electrician, who is to be seen standing in the door of the car, by Mr. E. S. Reed, to be seen at the window, and by his only brother, Mr. Jonathan E. Field, besides receiving the able co-operation of that expert machinist and inventor, Mr. Rudolf Eickemeyer. With such a staff and so capable a head, one has a perfect right to expect most valuable and important achievements.

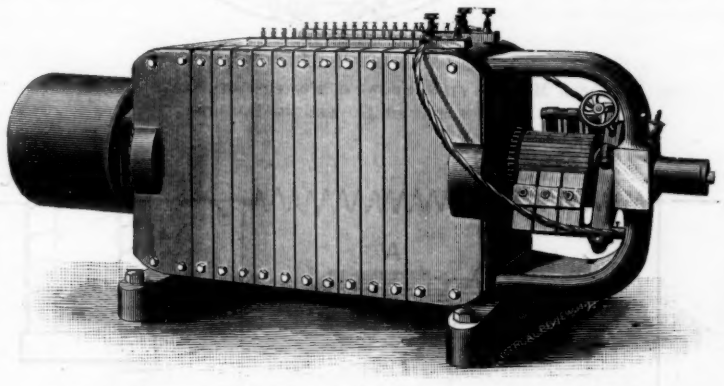

FIG. 2.—EICKEMEYER'S NEW IRON-CLAD DYNAMO USED WITH FIELD'S ELECTRIC MOTOR.

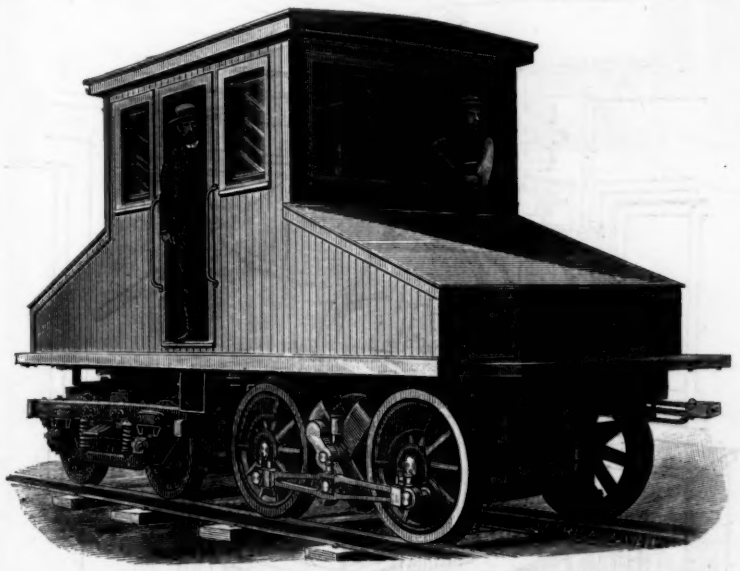

FIG. 1.—THE FIELD ELECTRIC MOTOR AND CAR AS IT APPEARS ON THE THIRTY-FOURTH STREET ELEVATED ROAD, NEW YORK.

The first electrical railway in America, with full depot and tram service in accordance with the plans of Mr. Field, was operated at the Chicago Exhibition in 1882. A very much smaller road was operated in Stockbridge, Mass., in 1880, and in 1879 the first public record of the Field motor system was filed in the U. S. Patent Office.

Secondary Batteries.

A VALUABLE CONTRIBUTION TO THE LITERATURE OF THE SUBJECT BY DR. LOUIS DUNCAN, BEFORE THE ELECTRIC CLUB, N. Y.

The regular monthly meeting of the Electric Club was held at the Hotel Brighton, Coney Island, Thursday, August 18. This was the last of the seashore meetings, and the announcement was made in the programme that the next general club meeting would be held in the new club house, No. 17 East 22d street, as soon as the improvements were completed.

"Secondary batteries" was the topic of the evening, Dr. Louis Duncan, of Johns Hopkins University, delivering the address which appears below. In addition to the regular club attendants, Lieut. Zalinski, of the United States Artillery, and two Spanish officers, Capt. Severo Gomez Nunez, Spanish Artillery, and Lieut. Remigio Goininez y Zapatero, Spanish Navy, were present as guests of the club. The address and discussion are given below:

THE ADDRESS.

In my paper this evening I cannot bring before you any new experimental results, nor the deductions from prolonged practical experience; I have obtained my material largely from the published results of others' work, taking what seems best. The data is incomplete, and sometimes its accuracy seems questionable. Probably when I have finished some experiments which I am about to try, I will have materially modified the views I am about to express.

The first practical secondary batteries of the lead-sulphuric acid type were made by Planté. A current was passed between lead plates immersed in dilute sulphuric acid, a thin coating of peroxide of lead being formed on one of the plates, while the other was practically unattacked. The current was then reversed, the peroxide already formed was changed to spongy lead, while a coating of peroxide was formed on the plate at first unattacked. By repeating the process the layers of spongy lead and peroxide grew thicker and thicker, and the capacity increased. The great disadvantages of this type were the weight for a given storage capacity, and the time it took to "form" them. These disadvantages have been partly removed, but the type of battery is not, to my knowledge, in extensive commercial use.

To avoid the long-forming process necessary in the Planté type of cell, the plan was adopted of covering the lead plates with some salt of lead, and reducing to peroxide and spongy lead respectively on the two electrodes, by means of a current. It is on this plan that most of the cells sold to-day are made. In speaking of them I will generally refer to the type manufactured in this country by the Accumulator Company and the Julien Company. They are made by pasting red lead or litharge, moistened with sulphuric acid, into square holes in a cast-lead "grid." These holes extend completely through the "grid," and are of an hour-glass form, the contraction in the middle being in-

tended to hold in the plug of active material. After being pasted and dried, the plates are put into a cell containing dilute sulphuric acid, and a current is passed through, changing the positives, *i. e.*, those through which the current enters; into Pb, O_2; the negatives into spongy lead. They are then taken out and washed.

Such, briefly and generally, is the method of manufacturing the plates; there are special methods employed by different manufacturers, but they are not important at this point.

Let us take a number of these plates and make up a cell such as I have before me—positives burned into a lead strip, negatives burned into another strip; the two sets put in a box containing dilute sulphuric acid, specific gravity, say 11.70, the plates, alternately positive and negative, being prevented from touching by some insulating material—rubber bands or plugs. Let us send a current through this until it is fully charged, then let us first discharge it, second, charge it again, and considering the phenomena which take place, let us try to draw from them some conclusions regarding what goes on inside the cell, the causes of deterioration and loss of energy, and the possibilities of improvement.

I shall not discuss the matter from a chemical standpoint, nor shall I attempt to accurately fix the chemical actions which occur, but I will try to determine the general nature of the actions and the causes of those which are deleterious, in order to suggest means of avoiding them.

If we close the circuit of the cell we will find that the difference of potential between the terminals is somewhere between 2.10 and 2.20 volts. In a few minutes this falls to about 2 volts and remains nearly constant for a considerable time—supposing the discharge is slow— hen it will begin to fall at a constantly increasing rate, and finally the discharge will cease. The internal resistance will increase as discharge continues. And I would observe here that what is usually given as the E.M.F. of the cell is simply the difference of potential between the terminals, and does not include the fall of potential in the cell itself. As records of the internal resistance do not accompany the observation, we cannot calculate this. In fact, I have never seen a systematic set of observations on the internal resistance of a battery during charge or discharge; such observations would be important, and their absence is to be regretted.

To come back to our cell, if we look at the plates during the discharge, we will see after a while small white patches, which will gradually grow as the cell becomes exhausted, until finally, if we allow it to fully discharge, the whole surface will become white. Again, if we observe the density of the acid we will find that it constantly decreases. If we test portions of the plates for lead sulphate we will find constantly increasing percentages on both plates. When the cell is run down completely we will find that from 20 to 35 per cent. of the lead and peroxide have been changed into sulphate.

Now let us recharge the cell. As soon as the current is turned on, the difference of potential at the terminals will increase to about 2.10 volts. If there is not much white sulphate on the plates there will be only a slight evolution of gas until charging is nearly completed, when it will be given off freely from the positive plate. If the gas be analyzed it will be found to be oxygen.

The difference of potential will increase until it reaches a value of about 2.50 volts; in a particular case it followed the curve given. It will be found that if we get 100 ampere hours upon discharge it will take about 120 ampere hours to charge the cell.

To sum up, the differerence of potential at the terminals falls upon discharge from, say, 2 volts to 1.90 in actual working, and rises when the cell is being charged. Oxygen escapes from the positive plate. The results are: Charging, greater part of negative plate to lead; of positive to lead peroxide; specific gravity of acid, say 1.205; discharge, negative plate, lead and lead sulphate and ?; positive plate, lead peroxide and lead sulphate and ?; acid specific gravity, 11 70 say. Let us put before us a deduc ion of Sir William Thomson, from the principle of the conservation of energy: "In a closed conducting circuit the total intrinsic E.M.F. is equal to the dynamic value of the sum of the chemical actions going on per unit of electricity conveyed, diminished by the energy expended in generating irreversible heat, etc."

Again, to quote Maxwell, "If the action of a cell consists in part of irreversible processes, such as (1) frictional generation of heat by resistance, (2) diffusion of primary or secondary products, (3) any other action which is not reversed when the direction of the current is reversed, there will be a certain amount of dissipation of energy, and the E.M.F. of the circuit will be less than the loss of intrinsic energy, corresponding to the electrolysis of one electro-chemical equivalent."

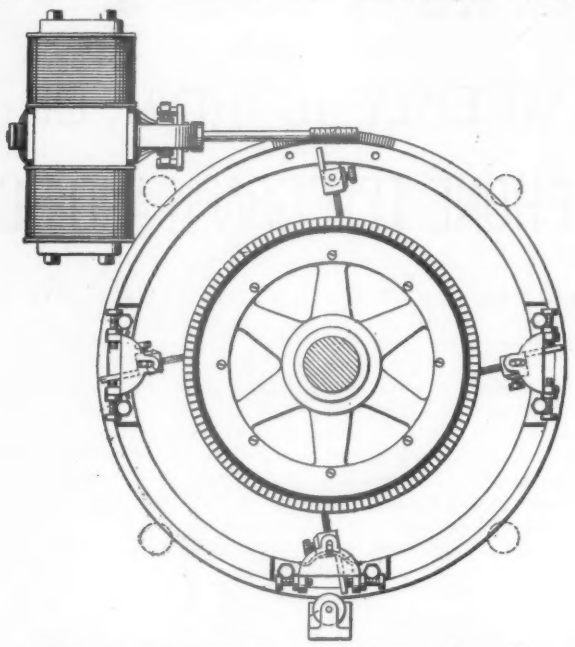

FIG. 5.—FIELD MOTOR—VIEW SHOWI G POSITION OF SMALL MOTOR AND ARRANGEMENT OF GOVERNING BRUSHES.

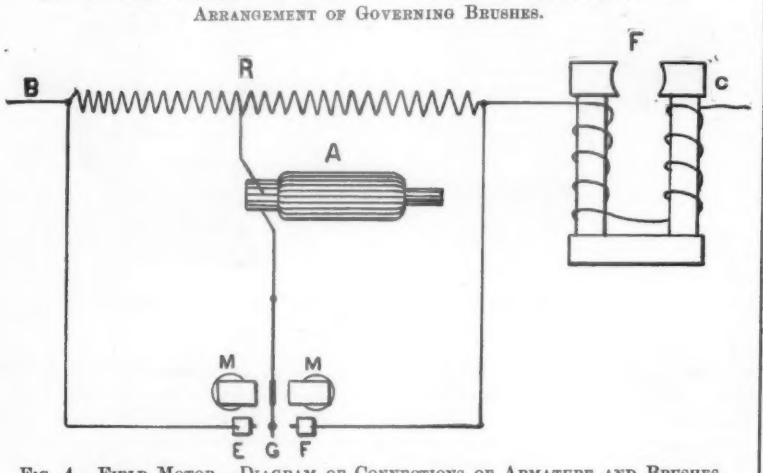

FIG. 4.—FIELD MOTOR.—DIAGRAM OF CONNECTIONS OF ARMATURE AND BRUSHES.

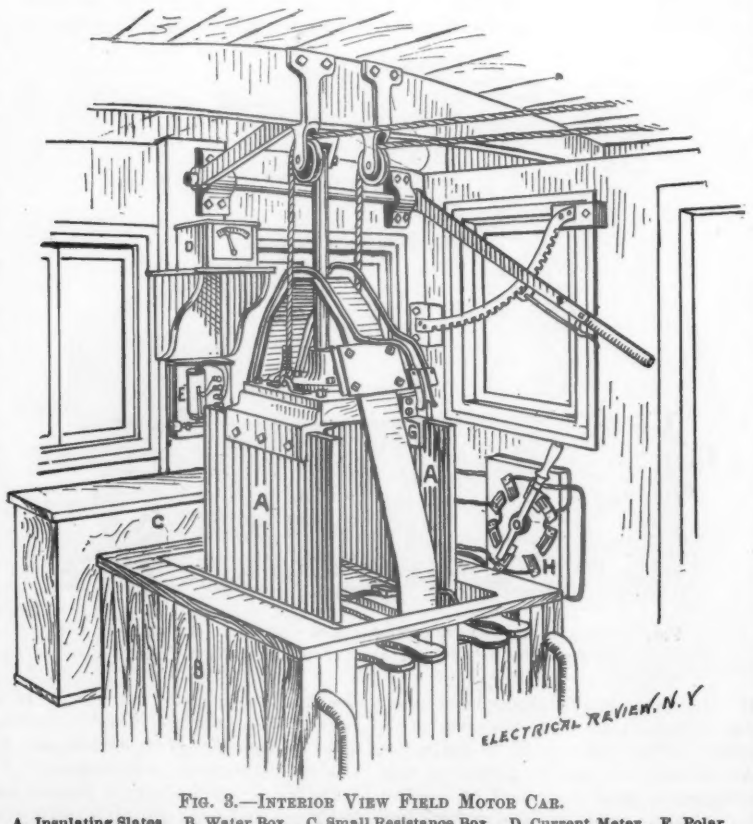

FIG. 3.—INTERIOR VIEW FIELD MOTOR CAR.

A, Insulating Slates. B, Water Box. C, Small Resistance Box. D, Current Meter. E, Polar Relay. F, Lever for raising Insulating Slates. G, Cut Out Plug. H, Reversing Key.

Now let us try to find the cause of the changes in E.M.F. during charge and discharge. They may, as we see, be due either to changes in the chemical action or to changes in the values of the disturbing causes. If it is the former, the continuity of the values, shown by the curves, would indicate that it is not due to a passing from one action to another, but rather to a change in the relative amounts of actions going on at the same time. If it is due to changes in the disturbing effects, then—as the most important one is the generation of heat—we would have the cell heating as the E.M.F. fell, becoming cooler as it rose again during charge.

I have no doubt that such an effect does take place: but I think we will see that part of the change in E.M.F. is due to changes in the chemical action.

We have, in a storage cell, besides the loss in "voltage" that we have been considering, a loss in ampère hours; that is, if we charge a cell at the rate of one ampère for 120 hours, we will only get out of it, say, an ampère for 100 hours, and this, as we have seen, at a diminished E.M.F. It is generally supposed, I believe, that this loss is due to corrosion of the support plates—to local action. In some cases this is partly true; but it still shows itself in "lithanode" plates, where there seems no possibility of local action, and in well-protected plates of the "grid" type, even if they are discharged immediately after charging.

There is another fact that bears on the point I am trying to get at—the continual formation of inert compounds—and that is the liberation of oxygen every time the cell is charged. If oxygen and only oxygen is constantly leaving the cell and is not being replaced, it would seem to point to the formation of some compound other than those which were originally in the cell.

These facts, then, the changes in E.M.F., the loss in ampère hours and the liberation of oxygen, seem to me only possible to explain by supposing that the chemical action consists of two parts, a principal action, reversible, consisting probably of the formation during discharge of $Pb.SO_4$ on both plates, and secondary actions forming products not afterwards reduced, occurring at the same time. The changes in E.M.F. would then be partly due to changes in the relative amounts of these two types of action the loss in ampère hours would be partly due to the formation of these inert compounds, and the loss of oxygen would be due to the fact that they contain less oxygen than the original components of the cell. From what has been said of the change of resistance in the cell—it is evident that part of the change in E.M.F. is accounted for in this way; but I think that the causes suggested above also exist.

Now let us try to find the reason of the formation of these inert compounds—supposing they really exist—and the remedy for them.

We have a few facts to guide us. During slow discharge the E.M.F. remains nearly constant for a time, then drops continuously. If the discharge be rapid the E.M.F. falls quickly, but if the circuit be broken for a while the E.M.F. returns to almost its original value, and the discharge can be repeated several times. Again in an experiment of Gladstone & Tribe to determine the effect of different strengths of acid, they found that until the dilution was 1 to 500, the chemical action on the lead plates seemed the same, lead peroxide only being formed after that. "The amount of oxygen fixed, and therefore of corrosion, was doubled, while the chemical action was different. On parts of the electrode a mixture of yellow and puce colored oxides was formed, on other parts a white substance was formed which was easily detached, falling in clouds into the liquid. Where this took place the amount of corrosion was greatest."

The reason of the formation of inert compounds seems to me to lie in the different

(*Continued on page 6.*)

Electricity Direct from the Energy of Coal; or, Mr. Edison's "Pyromagnetic Generator."

The production of electric current, or mechanical motion, directly from the energy of coal has always been an interesting problem for inventors. Of all attempts in the past, the thermopile has been more reliable, (yet not very efficient), and somewhat more durable, than other devices. But none has been of more than theoretical importance. Fig. 1 is a drawing of Mr. Edison's latest work in this direction, which bids fair to revolutionize the methods of producing at east small quantities of electric current.

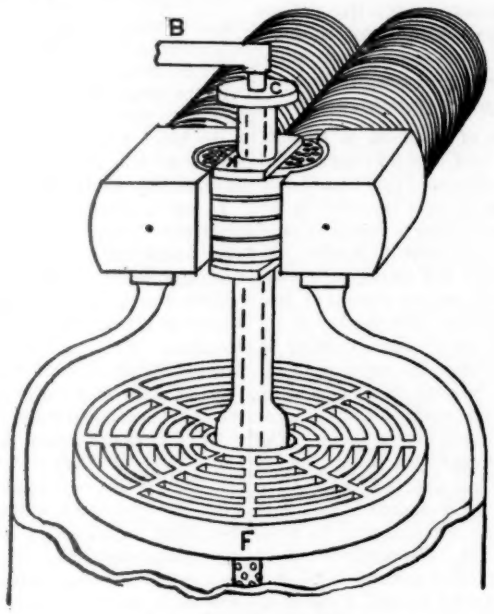

FIG. 3.—PERSPECTIVE VIEW.

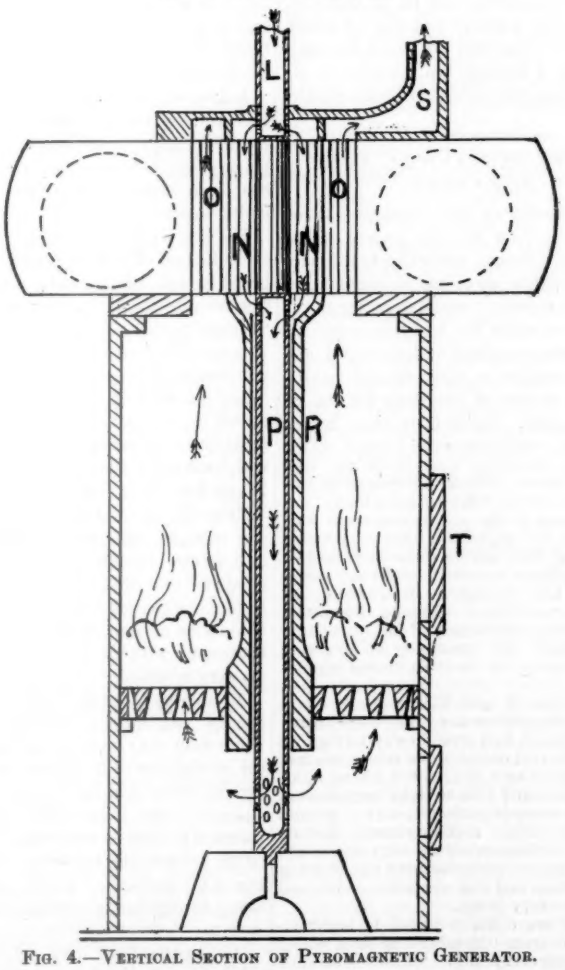

FIG. 4.—VERTICAL SECTION OF PYROMAGNETIC GENERATOR.

The electro-magnets (*M M*, etc.), supplied with current from an external source, or from the machine itself, have their poles placed near two circular plates of iron. Through these, tubes, made by rolling corrugated sheet-iron, are inserted. The tubes are wound with coils of insulated copper wire, connected in series. From the wires joining each two coils, connection to brushes is made, as many in number as there are coils of wire on the tubes *A A*. These brushes press on a ring of insulating material, in the circumference of which is inserted two pieces of copper, connected, respectively, with the metallic rings *E* and *D*, on which press brushes connected with the external circuit. The shaft, on which the rings mentioned are fixed, extends down, and is attached to a guard-plate, *G*, of fire clay. In Fig. 2 this is lettered *W*, and is represented as covering the openings to four of the eight tubes. The shaft is hollow, and cold air is forced down through it, and passes into the hollow of the guard-plate, and thence upward, through the four tubes immediately above. Hot gases from the fire beneath the guard-plate are meanwhile passing upward, through the four other tubes, the magnetic capacity of which is lessened by the heat, weakening the field in which are the copper coils on these tubes. Currents are, therefore, generated in the copper coils. Continuing the rotation of the vertical shaft, the tubes are successively cooled and heated. When the heated iron cores are over the guard-plate, they begin to cool, and the current reverses. The closed magnetic circuit is in this apparatus opened by heat, and closed again by cooling. One side is always gaining, the other losing heat. One side is always warm, the other cold. The analogy to a Gramme ring is striking, in which one side is of north, the other of south polarity. The reversal and commutation of the induced currents is the same as in an ordinary dynamo, with the exception that the brushes take the place of the commutator bars, and the metallic pieces in the revolving insulated ring the place of the brushes.

Fig. 3 gives a perspective view, and Fig. 4 a vertical section of the pyromagnetic motor. Cool air enters at *B*, and passes through the hollow tube (Fig. 4) *L*, is deflected by the guard plate, passes through that portion of the interstitial tubes *N N*, or that much covered by the guard plate *K*, as shown in Fig. 3. The air then enters the tube *P*, and escapes from openings in it below the fire, and thence upward through the grate, and before passing out at *S* heats the tubes *O*. These are rendered by the heat non-magnetic, are no longer attracted by the poles of the electro or permanent magnet, between which the armature is placed. The portion *N N* is, therefore, attracted, which, as it moves from under the guard plate, is heated, and the part *O O* passes under the guard plate to be cooled. The guard plate *K* is placed at an angle of 45°, with the lines of force between the poles of the magnet. The power is transmitted from the pulley *C*. The air which cools one part of the armature and is therefore warmed, prevents the hollow shaft, *P*, from being burned. This is still further protected by a covering, *R*, of fire clay. The above illustrations have been drawn to make clear the principles of the machines, which, for practical purposes, would vary somewhat in general plans and details. If the guard plate is placed at right angles with or parallel to the line of force, there will be no tendency for the shaft to rotate.

FIG. 2.—GUARD PLATE COVERING OPENINGS TO FOUR VALVES.

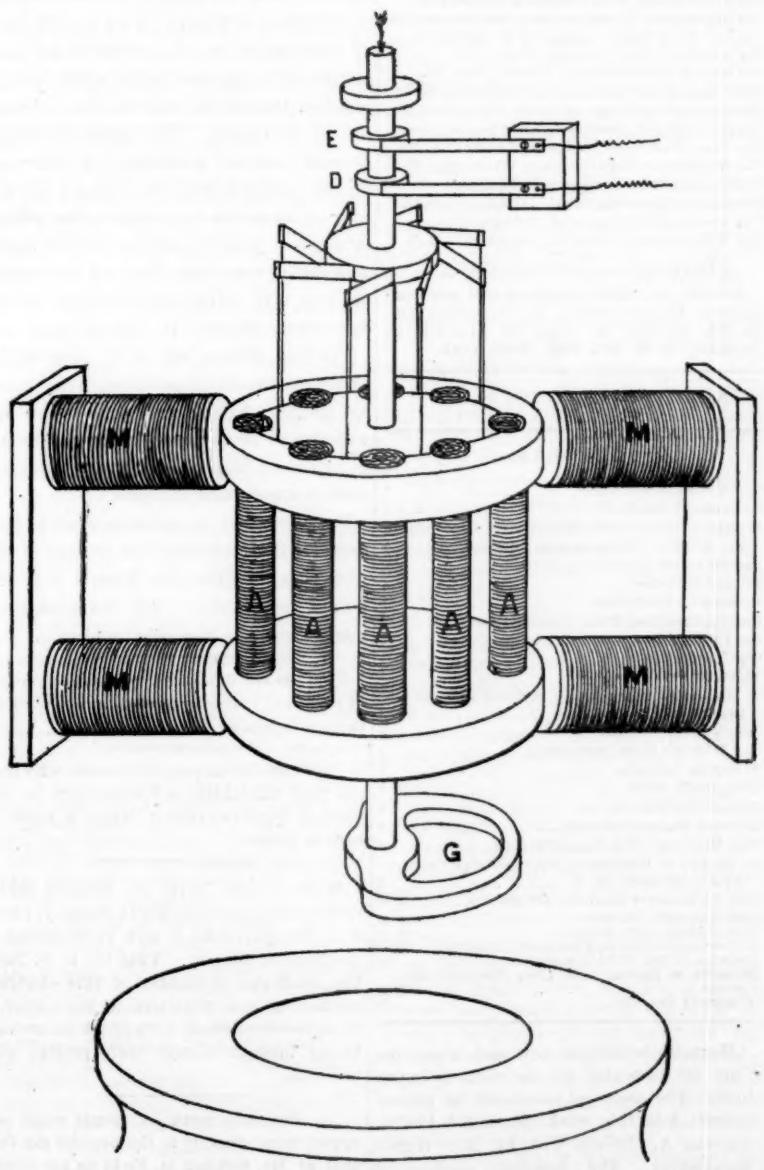

FIG. 1.—EDISON'S PYROMAGNETIC GENERATOR; THE METHOD OF GETTING ELECTRICITY DIRECT FROM THE ENERGY OF COAL.

The motor converts heat directly into mechanical motion without the production of electricity. For powerful machines, an electro-magnet would be employed, and the current to excite it taken from a small dynamo driven by the motor itself.

The Telephone Convention.

Secretary C. H. Barney announces that the ninth meeting of the National Telephone Exchange Association will be held at the Monongahela House, Pittsburgh, Pa., commencing on Monday, September 26, next, at 11 A. M. The rates at the hotel will vary from $3 to $4 per day, depending on the class of rooms occupied. Several papers of more than ordinary interest have been promised, and it is desirable that members intending to read papers should give notice at once to the secretary of such intention, and of the subject of the paper.

The New England Butt Company, of Providence, the largest manufacturers of braiding machinery in this country, was represented by Mr. J. F. Blauvelt, at the Convention, who reported an increased demand for their braiders by the wire manufacturers.

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Magnetic bridges in new and interesting form are presented in our columns in this issue. The electrical world will be greatly interested in this work, presented by Mr. Thomas A. Edison and by Mr. Rudolf Eickemeyer. The magnetic qualities of metal can now be easily and accurately determined—a very desirable result.

Prof. Badt's paper on "Danger to Human Life from Electric Currents," read before the Chicago Electric Club last Monday, is a valuable contribution to the history of this very uncertain and at all times mysterious work of the electric current. We publish the paper in full. It is the most complete and instructive review of the subject that we have seen, evidently the work of not only an able electrician but one who has given his subject much careful study and research.

PATENTS BY THE "ELECTRICAL REVIEW."

We to-day announce to our readers that we shall on September 1st start a new department of the REVIEW, to be known as the ELECTRICAL REVIEW PATENT BUREAU.

The new Bureau will be conducted under the direct personal management of Thos. J. McTighe, Esq., the well-known patent attorney, formerly of Pittsburgh, Pa., whose fourteen years of practice has given him a fund of general information and a most valuable experience in all the details of such a business as will be transacted by our new PATENT BUREAU.

It is not intended to confine its operations to electrical branches of invention; in addition we confidently offer its resources and ability to inventors generally. Yet we shall endeavor to make electrical patents and electrical work a special feature. Mr. McTighe possesses peculiarly fitting qualifications for such a purpose. Many years of practice have necessarily made him familiar with a wide range of subjects in the various lines of manufacture. But he long ago realized in his practice the comparative worthlessness of a mere "book knowledge" of theory in the branches of electricity, and determined to gain the insight which is only acquired through the hard knocks of practice in the factory. The great advantage of such practical knowledge of electrical science, coupled with the intimate knowledge of the patent law and practice gained in fourteen years' experience, we are confident will be fully appreciated by the inventors who may entrust their business to the ELECTRICAL REVIEW PATENT BUREAU.

The new Bureau will do no *cheap* work, such as thousands of patentees to-day know too late they have had done for them, but will always be as moderate in prices as circumstances will justify—believing that good work is always worth its price.

For particulars, see advertisements as they appear. Inventors from all sections of the world may address the Bureau with the utmost confidence. All correspondence therewith will be *absolutely confidential*.

There is not much rest for the chronicler of electrical events and electrical inventions these progressive days.

The scientific or practical reader who does not find something to interest him in this issue of the ELECTRICAL REVIEW must be hard to please.

While in New York, Dr. Duncan paid a visit to his former comrade in the navy, Lieut. F. J. Sprague, who is now convalescent at his home in this city. That the U. S. Navy has graduated a number of able electrical workers is well illustrated in the career of these two gentlemen, both of whom are very young men to occupy their present high positions.

No electrical work of recent years will appeal more directly to the popular ear than that of Mr. Stephen D. Field on his electric motor, which is now standing on a switch on the New York elevated road at Thirty-fourth street. The work of preparing this branch of the road for a comprehensive test of the motor is proceeding carefully and thoroughly, Col. Hain, the general manager of the elevated, having given Mr. Field and his associates every facility for prosecuting the work. Within the next few days a trial trip will be made, and while it is never safe to predict in an instance of this kind, the REVIEW is confident that Mr. Field will see triumph crown his years of stubborn, earnest work, and that a new era in elevated and surface car traction is at hand.

STORAGE BATTERIES.

The thoughtful paper on "Secondary Batteries," read by Dr. Louis Duncan, of Johns Hopkins University, before the Electric Club, is worthy of careful perusal and consideration. While granting to the accumulator a position of strength and importance in electrical work, he calls attention to the restrictive effects that the advance of the electric motor and long distance incandescent lighting will have in utilizing the heretofore idle hours of the electric plant and in making valuable use of its surplus energy. The Doctor, at the same time, predicts great improvements in the storage battery as it is known to-day. His address and the discussion which followed we publish in full.

COOKING BY ELECTRICITY.

Resistance coils of platinum or German silver wire have been used for experimental cooking. The currents used have been of constant direction and the coils traversed by the currents must needs be in or in close proximity to the substance to be cooked. Further, the surface exposed by a coil taking up considerable room is small, and the amount of heat radiated and conducted from the wire if not nearly red hot will not be large. Cooking by electricity has not come into use as yet; the use of alternating currents offers a solution to the problem. A large electro-magnet of great self induction is constantly in circuit. The loss of current through this coil as long as metal is not brought near it is too small to be measured. It being desired to cook flapjacks, an iron spider is placed over the poles of the electro-magnet. The rapid reversals of current in the coil induce currents in the iron spider, which is thereby heated. For heating liquids, a copper vessel is preferable where it can be used on account of its greater conductivity. The metal in which or on which the cooking is done need not touch the magnet. Indeed, a lessened heating effect is obtained by separating the dish from the electro-magnet.

CAREFUL ELECTRICAL WORK DEMANDED.

Another victim of poor insulation is recorded in the New Orleans papers of last week. Frank Young, according to the published statements, who was an employe of the Brush Company, "while standing on the gallery of the house No. 66 Union street, repairing a wire, accidentally leaned over and his body touched a wire through which there was a current of electricity for the incandescent light. As his body came in contact with the wire he received a shock which killed him instantly, and throwing him across the wires, where he remained suspended until taken down by his friends."

Incongruous as the above statement may appear, it is not impossible that a so-called incandescent line, having some new-fangled modern appliance attached, might be exactly the proper kind of death trap to accomplish the result mentioned. Pseudo inventors, and self-styled electricians, if not very carefully watched, are constantly endangering life and property by their damnable ingenuity.

One of these M. and E. E. sort of chaps reads up Zippernowsky, or some other owsky's system, and straightway he rigs up an induction coil out of some refuse magnet wire, hitches it on a line with 2,500 or 3,000 volts pressure, and tries to light incandescent lights on a secondary circuit, with a ground on his line. They make dynamos, meters, insulators, testing apparatus—any and everything that can be manufactured out of scrap heap materials, and risk a sacrifice of life and property at every jump.

Linemen are often required to make repairs—aside from trimming—on lines which are carrying very high tension currents. For Legislatures desiring to do something in the electrical line next winter, it wouldn't be a bad idea to make it a penal offense to require work of a risky character done on such wires.

Chicago has taken the lead in this as in some other electric light matters. A general order from the managers of the Chicago Arc Light and Power Company positively prohibits the taking of that form of risk by any employe.

The loss of a hundred lights put out, and fifty motors stopped, would not be a drop in the bucket compared with the life of a one-legged, frowsy-headed, impudent little newsboy.

OUR CHICAGO LETTER.

(From a Special Correspondent of the ELECTRICAL REVIEW.)

The Indiana telephone war has taken a change of venue, so to remark. At La Porte the innocent people have been induced to believe they could use any telephone at will, and, consequently, the field has been opened and cultivated by the Cushman American people, who opened an exchange. Then the Bell people came in with twelve suits for infringement and damages in the U. S. District Court.

Superintendent Hockett, of the Central Union Company, says that the suit pending in Chicago is in a fair way to be reached for final argument in October.

In the meantime the parent company in Chicago is putting out instruments, still firm in the belief that it is doing the right thing. Somebody will come in out of the wet in this telephone matter pretty soon, now.

In the intervals between customers the other day—being interrupted half a dozen times—McKinlock, of the Central Electric Company, while the subject of cash carriers happened to be up, told about an advertising scheme of a young merchant up in Northern Michigan. To draw custom from his competitors he put in a cash carrier that ran to the desk at the back end of the store. Inside the desk he had a false nose and a wig.

When a customer paid, the cash, the article, a piece of paper to wrap it, all went into the car and was fired up to the desk. Then the proprietor walked back to the desk, held an imaginary conversation with the cashier, whose face, wig, and false nose appeared at the cash window; the change was made, and the basket came back to the counter, followed by the proprietor.

"You see," said Mc, "he had no clerk, and so he played double, but his customers didn't find it out before increasing business permitted the employment of a cashier."

A few weeks since mention was made in the REVIEW of the difficulties which surrounded the investigations in the matter of market reports which "get away," and there has been considerable ingenuity exercised trying to ferret out the evil schemers.

The last catch is somewhat amusing. Despite the best efforts for prevention, the open board would keep getting quotations. A proverbially sharp "regular" discovered that for some purpose or other a curious box arrangement had been placed behind the quotation board, filling the space between the board and the wall. A door in this box permitted ingress and egress to a man, who evidently went in empty and came out loaded with quotations which ran off the ends of his fingers like water from a duck's back.

Then the regular bit his thumb and thought and thought, and then he climbed high up into a new building, poked his head and stomach into the space above a window frame, and peeked down and into the recess behind the mysterious box. The fellow was loading up with a telephone receiver, and the mystery is solved.

A telegraph operator's life is not a quiet one by any means, and he hopes for rest when dead; but over in Indianapolis, when the mortal part of H. J. Nichols, an operator, arrived from Kansas City, it was held for charges. The judge before whom the replevin was sued ordered the body delivered to the friends, the matter of charges, according to his notions of justice and humanity, being susceptible of settlement in some other way.

An electric light man out in Lake View, this county, is a little romantic. A soldier, he deserted, and gave himself away to intimate friends. His relative, the wife of his employer, told of this, and the young gentleman went to Leavenworth prison, where he served two years. Then he came back, renewed his acquaintance with the family, and boarded with them.

Meantime his cousin's daughter had grown to be a buxom lass of fifteen, with the development of riper years, and they fell in love, just as anybody's father and mother did, and, being opposed, skipped together,

just as most anybody's father and mother would have done, nine times out of ten.

The wonder-mongers told many wise tales of revenge, of ruin, broken hearts, abduction, and all that sort of thing, and a runaway butcher's cart, with a drunken driver and his girl, was ingeniously connected with the escapade by one of the dailies. The scandal didn't stick, and Charley Pitcher and his rosy little bride are safe from vicious threats and gabbling gossip over in Kansas.

The dogged tenacity with which a prejudiced community or class will hang to an exploded theory, and defend it, is well illustrated by recent events in a town somewhere in the West, where an underground ordinance is worrying the old (electrical) settlers. They have all the old chestnuts about impracticability, impossibility, etc. They state that there is no town in the Union where underground wires have been placed that are in use by electric light systems, by the telegraph and telephone people, or by the cities themselves. They show, too, how dangerous to the health of the people would be the tearing up of the streets; how miasma would rear its reeking head and distill its noisome vapors, and slimy cholera would writhe and wriggle its hideous form through the alleys and streets, till the "abomination of desolation," spoken of by the prophet, would be accomplished.

New York and Chicago have gone through these premonitory symptoms, and survived. There is as much similarity in towns as there is in people; and there is no more difference in people than there is in folks.

Ludington, Mich., is to be lighted by electric light, and the Brush Company will put in both arc and incandescent systems in the city for either public or private use. The local company is formed of the best men in the city, and the salt and lumber interests are well represented. The city will, as a starting point, accept 25 arc lights, which are to be running in one month, and the public will be served at once, forty lights having been subscribed for in advance. The incandescent system is to be ready in 90 days, when the city buildings will be lighted by the glow lamps.

The struggle for supremacy in the matter of lighting our inland waters was decided in favor of the Western Electric Company. Some of the other boys felt a little sore, and entered their protests, but the Commissioner of Public Works, after giving the matter much supplemental thought, finally decided, as a lawyer would put it, that a supersedeas should be denied and a new trial refused.

Prof. Barrett says that the plant will be running in sixty days.

The practical results of Admiral Barrett's system of "bossing the bridges," are daily becoming more apparent. A conversation by telephone is always funny to an outsider, but in the vessel handling it is quite comical at times.

Down go two drops, at once, while the Commodore is talking to a third party.

"Hello, Twelfth! She does. Well, hold her. Notify me. Hello, Rush! In about three minutes. Tell him to keep his hair on! Wait till I say so. Hello, Madison! Much traffic? All right. Open for the in run, when it comes. Hello, Rush! Let 'em through, and tell 'em to make good time. I want to close Madison between this and the out-bound fleet. Hello, Clark, let your excursions out now, while the in fleet is passing. Lively, now! Hello, Twelfth! Yes, now. Hello, Polk! Bear a hand, my lads, turn 'em loose!" and so on, with variations.

The great advantage gained by holding a boat here, hurrying one there, and making the whole system "splice" properly, is more apparent daily.

At Rush street, the outer bridge of the main river, the average time of open bridge in one day was 13.7 minutes per hour, and during that time 156 vessels passed in and out, the average time per swing being 4.1 minutes.

Lake street, which, like Rush, is a steam bridge, passed 89 vessels at 42 swings, with an average duration of 5.1 minutes each, and the Clark street bridge averaged 7.2 minutes open per hour, to pass 100 vessels.

The system of rewards and punishments is quite simple. If a vessel gets too slow, she is liable to get "bridged" and wait the next opening. As a rule, they don't let it occur again. The rewards are smiles from the commodore. Commodore (late Captain) Weckler, who has had abundant experience, has all the tugmen helping, and the results are astonishing. The bridges, to day, are only open about twenty per cent. of what they used to be, and the orders are given in every instance where they will do the most good.

And the whistles! they are dead with a great big D.

CHICAGO, August 22, 1887.

OUR BOSTON LETTER.

(From a special correspondent of the ELECTRICAL REVIEW.)

In a thriving New England city, whose name means foresight, an imposing building of brick and stone stands on a main street. High up supporting the frame are granite blocks, on which are cut the words, What Cheer (?) the name of the building On the ground floor are the offices of the gas company. It has not yet consolidated with the Electric Light Company.

Complaints multiply regarding the inconveniences caused by opening the narrow streets to lay water pipes, underground wires, etc., until even the worst croakers say nothing about putting all the wires underground.

The Mather Electric Company have of late made changes in several directions, the most recent being the establishment of their agency in Boston.

Messrs. Claflin & Kimball have opened an office at 143 Federal street, Boston, where the Mather incandescent system will be handled for New England and all installations put in working order at shortest notice consistent with the best workmanship.

The Mather system seems to be gaining rapidly in popular favor and to be working into different channels in a practical way, which must prove gratifying to the management and satisfactory to the stockholders.

The Mather Company have now been on the market several years and have made a large number of installations in different States—from the Atlantic to the Pacific—several plants having been installed in the Southern States during the past year.

The Boston office has been put in the hands of the new firm for the purpose of pushing the system among the many large manufacturing establishments scattered through New England, and Messrs. Claflin & Kimball are prepared to furnish incandescent plants in any size called for—from 25 lights of 16 candle power up to any number—with or without complete steam plants, and all accessories.

The dynamo of the Mather system stands high for efficiency and reliability under full or partial load and long runs.

The incandescent lamps are now sent out in 16, 20, 24 and 32 candle power.

The new arc lamps and dynamos of the Mather Company will be put on the market the present season in various sizes of dynamo and full arc lamps.

The new firm have the best wishes of a large circle of friends, as both are Boston men, and they will shortly show the Mather dynamo and lamps in daily operation at their office and adjacent building.

Boston, August 23, 1887.

Electricity and Life.

To the Editor of Electrical Review:

In your issue of June 4, Mr. W. L. Stonex stated a view of "Electricity as the motive power which causes the blood to circulate," which is part of a much larger view of electricity as the motive power in life of every form, which I had worked out nearly ten years since, and a concise statement of which I have lately published in a pamphlet which came from the press—the Riverside Press of H. O. Houghton & Co.—June 3, but which was written seven years since, as an abstract of a treatise which in its first shape had been still earlier completed. From the pamphlet may be seen what in general the view is, and the extent to which I have carried it out. My treatise has grown to a very large work embracing a review of a very great array of facts; everything, in fact, connected with the life of both animals and plants, their forms and functions, their origin and evolution, and all going to show that by means of the oxygen of respiration both the animal and the plant are electrically animated, and that electricity alone is the moving power and the making agent, in all living things, the sole force within nature, and the medium through which the Creator of nature has wrought every feature of natural creation. In fact, I find ample reason for the belief that there is in the natural universe no other form of force than electricity, and that all other so-called forces are in truth results of electrical action. I send a copy of my essay, and a second for Mr. Stonex.

Very truly yours,
EDWARD C. TOWNE.

A Method of Telephonic Communication Between Ships at Sea.

BY PROFESSOR LUCIEN I. BLAKE, OF TERRE HAUTE.

In February, 1883, while investigating at Berlin, the experiments of Colladon and Sturm as to the velocity of sound through the waters of Lake Geneva, the thought occurred why not make a practical use of water as a means of communication between vessels at sea. Several methods were immediately devised with the valuable suggestions of Dr. King, but as far as the writer knows, the thought, the experiments and the whole scheme antedate all methods which have been proposed for fog-signaling by telephone by sea.

Briefly, the plan was as follows: A sound-producing apparatus was to be attached to each vessel and to be worked under the surface of the water. In times of fog or night, a code of signals would be produced by it which would be transmitted in all directions through the water, with the velocity of from four to five times that in the air. Each vessel, in addition to the sound producing apparatus, would be provided with a sound receiving apparatus which would take up out of the water the signals arriving from neighboring vessels. All of us remember when, as boys in swimming, how distinctly the sound of the striking of stones together under water was heard. Just so distinctly is it possible to send musical tones from one ship to another. For steamships the sound-producing apparatus was designed to be a steam fog horn or whistle, specially constructed to sound under water, and to be heard at least from six to eight miles. From the nature of its tone it would be easily distinguishable from other sounds always more or less present under water, such as from breakers, waves, etc. With such whistles a Morse alphabet of long and short blasts and pauses was to provide a means of extended communication, while a simple universal code would indicate a ship's course. Since ignorance of the very presence of a ship, rather than incorrect estimates of her course, has been the principal cause of ocean collisions, the simple hearing of the sound would prove a most excellent general safeguard. Bell buoys were to have a second bell added under water, while lightships, lighthouses and any headlands might also be provided with submerged bells which could be rung from the shore, when necessary; sailing craft, both large and small, would have bells, and since an ordinary locomotive bell can be heard at least two miles under water, such simple means would seem to afford sufficient limits for protection to such vessels

It is believed that sufficient has been done, however, to show that the complete solution of this interesting and valuable practical scheme will lie probably in the telephonic method just described or in some modification of it: at least, by this method in October, 1885, signals were transmitted and received one and one-half miles on the Wabash River from a locomotive bell, around three or four windings of the river, so that the operators were out of each other's sight, and the sound could not be heard through the air, yet could with fair distinctness through the telephone. For want of space we have published but part of this interesting paper read by Prof. Blake before the American Association for the Advancement of Science at Columbia College on Thursday last. We shall publish this and some other interesting papers read at that meeting in a later issue.

Wants to Go to China.

To the Editor of Electrical Review.

DEAR SIR:—Will you please publish in the next issue of the REVIEW, the address of Mr Wharton Barker, or of a superintendent or general manager of the Philadelphia syndicate interested in the China enterprise, and oblige a SUBSCRIBER.

New York, August 20.

ANSWER:—Address Mr. Barker at No. 125 South 4th street, Philadelphia.

Col. Dickey's Work Increasing.

An official circular has just been issued as follows:

Mr. J. J. Dickey having resigned his position as Superintendent of Telegraph of the Union Pacific Railway lines to assume increased duties with the Western Union Company, Mr. L. H. Korty is hereby promoted to succeed him; to take effect August 15th, 1887.

T. J. POTTER,
Vice-President Union Pacific Ry.
R. C. CLOWRY,
Vice-Pres't and Gen'l Supt.
Western Union Telegraph Co.

Electrical Colonels.

(Written for the ELECTRICAL REVIEW.)

When we come to count them up, how many there are. And they are of so many kinds and origins, too; as many and as varied as the autumn leaves.

Some of them have roving commissions, and their parade ground, their battle field, extends from New York to San Francisco. There is for instance Col. H-p-g-od, a sort of trooper who rides from Harlem to Detroit with the greatest of ease, in pursuit of the common enemy. He gallops over the country with the air of the headless horseman, making more miles perhaps than any, save Col G-o-g- B-e-t-e, who is both a Massachusetts and Wisconsin colonel—a sort of a military twins, as it were. His title extends back to the days when he was on the staff of the late Count Du Moncel, headquarters numero grunt, Rue de la Bourse, Paree.

Another spectacled Colonel is H-s-i-s, formerly of Milwaukee, crowned after moving East. (Mem. East great place for titles.) Head as white as the wool on Mary's little lamb. Fingers wounded on one hand, but have nothing to do with military exploits or dangers. The colonel was the leader of a forlorn hope in a charge on the bull wheel of a threshing machine, years before the war.

Col. B-u-e C-a-d-e-r is a Texas Colonel. He commands a regiment of camels in the grand army of shriners. Col. W. A. S-i-e., of the V. D. P., is likewise a shriner. These two gentlemen, when rigged out in full regimentals—a Turkish fez and a scimetar—are perfectly gorgeous and altogether stunning.

C-a- W. H-m-o-d, K. C. B., of St. Louis, is a Missouri colonel. He commands a sort of iron brigade of electricians in which three-quarters of the members are majors and captains, and the privates are promoted in their eighteenth year. F-e-e-i-k T b-s, formerly of the Q. system, is an Illinois colonel. He owes his promotion to gallant services in sundry telegraphic skirmishes.

Col. L-r-y F-r-a- owes his title to the New Orleans people's appreciation of his gallant and exemplary conduct while introducing the "new catch 'em system, sah!" to the police authorities there. The system known as "a practical *habeas corpus*, sah!"

Omaha boasts of its Col. D-c e-, and Indianapolis has the one and only Col. W-l-l-k, whose aid and comfort in the olden times was Prof. W. W. S——h, now of Missouri. He and W-e-s, of K. C., are both on the list for promotion.

Col. W. C. B-i-t-l (brevet and brigadier-general) commands one of the largest armies of Poles in the United States. There have been many losses in Col. B.'s army in and around Chicago during the past few years, hundreds of his brave poles being compelled to bite the dust. They are also having a rough time of it in other cities. But Poles are quarrelsome everywhere.

Prominent among the military electricians, although of inferior rank, should be mentioned one who deserves the title of colonel. First to enrol—and in his haste without his unmentionables—in the service of his country when the scarlet fever of rebellion swept over the land, standing by the flag till it returned triumphant—having withstood the droning and whistle of the bagpipe four long years—it seems a pity that when so many should have suffered promotion, J-h- Y-u-g should still remain only a captain. Let us make him at least a major.

P-r-g-n- H-m-u-n is a for true and no mistake colonel. He fit into the war in the pay department, and was also a sutler. H-m-u-n can do more, probably, with electricity than any other military electrician in the United States. He is an inventor as well as a capitalist, and is sole proprietor of no end of quads, duplexes, 'phones—never says telephone—dynamos and motors than any man north of the Straits of Magellan. H-m-u-n is a daisy.

Besides the above-named military electrical celebrities, we have an okonite and a kerite colonel, and one simon pure rubber colonel, G-o-d-y-a-r. These last three have flexible, elastic commissions, and are liable to become brigadiers at any time after the next meeting of the association at Pittsburgh.

Telephonic News

⁂ Judging from the inquiries we have received, quite a large number of telephone workers are desirous of going to China to assist in teaching the natives how to use the telephone and in building exchanges.

⁂ Some of the telephone superintendents are now figuring up the numbers of calls per day, hour and minute received from subscribers in their exchanges, to report at the National Telephone Exchange Association. Don't get the figures too high, boys.

⁂ Speaking of telephones, they are about to have fun at Oakland, Ill. The Deputy U. S. Marshall, A. B. Briscoe, one day last week, at the instance of the Bell Company, served papers on J. S. Yeargin & Son, restraining them from using the American Cushman telephone. The case comes up in September.

⁂ A Houston, Texas, dispatch of the 9th announces the arrest of S. L. Barrett, electrical expert of the Barrett & Nelms Telephone Company, charged with embezzlement and theft. He is the inventor of a telephone transmitter without a carbon, and of a telephone, which was succesful, but declared to be an infringement on Bell's. The dispatch looks a little as if it might be an advertisement, inasmuch as it closes up with the sentence, "His salary here was $385 per month."

⁂ The writer (says a N. Y. *Sun* correspondent) was riding in Ocean avenue past the line of villas, which increase in number and beauty as the years go by. It was midday, and he had a view of two ladies waltzing in the parlor of Gen. Thos. T. Eckert, general manager of the Western Union. He fancied that they were casually practicing some of the frequent new styles in round dancing. But the rhythmic grace of their movements was not compatible with the seeming lack of music. He looked again, and saw that one was holding the receiver of a telephone close to her own and partner's ear, and that they reversed often enough to avoid winding themselves up in the connecting wire. Later he was shown the other end of the arrangement in a telephone directly over the orchestra in the West End Hotel parlor, where a daily concert is given at noon, and dance music is played from 8 to 11 every evening.

⁂ A dispatch from Indianapolis says: "Twelve suits were filed to-day in the Federal Court by the American Bell Telephone Company and the Central Union Telephone Company against twenty patrons of Cushman telephones at La Porte, this State, where the Cushman Company opened an exchange within the past week. The complaints are voluminous documents, reciting all the litigation heretofore had over the Bell patents, with reference to the decrees in the cases, and asking that each of the defendants be required to answer certain interrogatories with reference to the construction and details of instruments used by them, and that they be enjoined from making, using or selling such instruments, and that the costs of these suits be taxed against them. Concerning these cases Superintendent Hockett, of the Central Union Company, states that there is a suit pending against the parent Cushman Company in the Federal Court at Chicago, in which the evidence is all in, and on which the final argument will be had in October. The present suits are against the individual users of the Cushman telephones, and Mr. Hockett adds that it is the purpose to sue every responsible patron, as the Cushman people say they will put in a large number of instruments in the northern part of the State, and it is the determination of the plaintiffs to resist encroachments in every direction in which the same may be brought."

Secondary Batteries.

Continued from page 2.

strengths of the acid in the body of the active material, at different periods of charge and discharge. Diffusion in the dense plugs of active material must be slow; if the discharge is also slow, the strength of the acid in the pores—except in portions almost shut off from communication with the body of the liquid—will not greatly change until the formation of the more bulky sulphate has further increased the difficulty of diffusion, when the acid will become weak, the irreversible action—probably that described by Gladstone and Tribe—will increase and th E.M.F. will fall faster and faster. In the case of quick discharge, the diffusion cannot nearly compensate for the weakening of the acid in the pores caused by rapid formation of sulphate, and the E.M.F. drops. If the circuit be broken, diffusion increases the strength of the acid in the pores, and the chemical action is again largely a reversible reduction. The fact that the E.M.F. falls to zero when only about 20 or 30 per cent. of the Pb. and $Pb.O_2$ are reduced is due, I think, to the clogging up of the pores of the material, or possibly because the surfaces, both inside and outside of the mass, are covered with sulphate, leaving an unreduced core of Pb. or $Pb.O_2$. The rapid corrosion of the plate, due to quick or exhaustive discharge, is due probably to the weakening of the acid, producing the effect mentioned by Gladstone and Tribe. During charge the effect is reversed. Immediately upon the commencement of the reduction of the $PbSO_4$, a layer of more concentrated acid is formed next to the surface and the concentration increases until it is compensated for by diffusion. The conditions of charge and discharge are therefore very different. In one case the acid next to the surface is dilute, in the other it is concentrated, and I think that the actions, other than the reduction or formation of lead sulphate, must be different in the two cases, and that the amount varies with the dilution or concentration.

The loss of energy in a secondary battery must result in heating, in corroding the support, and in irreversible chemical action. Part of the loss of voltage—that due to charging at a higher potential than that of discharge—is due to the changes in the relative amounts of the actions going on, part to heating; the loss in ampere hours is due partly to the corrosion of the support and partly to the formation of inert compounds. This formation is mainly due to the varying strengths of acid in the pores of the material; its amount is to some extent indicated by changes in the E.M.F.

Let us see now what effect all this has on the life of the cell, and the best way to increase the life and avoid the losses of energy.

It would seem that the life of the cell is threatened chemically in two ways—the corrosion of the support, and the constant formation of an inert product drawn from and reducing the amount of the active material. From what has been said it is evident that both effects are increased by a discharge which seriously lowers the E.M.F. whatever it is due to, whether to quick or exhaustive discharge. The corrosion of the supports is not, I think, a serious matter, when the cell is properly cared for. The local action between the peroxide and support has been often discussed; the remedies are pretty well understood. It will be generally found that in well cared for cells there is a hard coating on the grid that cannot be easily penetrated by the acid, and which, therefore, greatly protects the lead beneath. I have artificially protected plates so that there is no local action, but I doubt if it is necessary in practice. I have seen plates covered with a hard crystalline coating, which have been used a long time with very little "*growing*." I do not think, then, that the corrosion of the grid greatly threatens a well cared for plate; it may, so far as this is concerned, last a great many years.

The other effect, however, the formation of an inert product, goes constantly on, and sooner or later the plate will need repasting. The remedy my argument would suggest is to increase the circulation of acid in the mass of active material; to make the plates more porous; to change their form so as to assist diffusion.

The economy of the cell follows the same laws that govern its life, the energy wasted being largely used in lessening this life. To decrease the waste, then, protect the support and increase the circulation.

Another important point—more important than storage capacity or even life—is the rate of discharge. I do not think I need dwell on its importance, especially for traction work. To obtain a rapid rate of discharge without a rapid fall of E.M.F. and deterioration of the plate, the suggestions I have already made apply. It is necessary simply to have a plate of large surface with free circulation within the mass.

Now having considered the type of chemical action that takes place in a cell, with a view of finding the direction of improvement, let us look at and criticize the mechanical construction of the more prominent types of secondary battery plate.

The type I have before me seems the most popular. It is a "grid" of lead—a casting with square hour-glass shaped holes through it, pasted with red lead or litharge. Usually the positive plate is pasted with red lead, although sometimes mixtures of red lead with litharge or peroxide are used. The negatives are pasted with litharge. The shape of the grid has some advantages and some disadvantages. It gives a large exterior surface of active material and if the plugs remain whole they cannot get out. On the other hand any pressure between the plug and grid has a component tending to push the two halves of the plug out, breaking it in the middle, and there is a tendency to weakness too at the middle, for as the salt is pasted in, it is compressed into the constantly narrowing hole until it reaches the middle, when it suddenly expands, giving a very definite line of weakness at this point. That there is a pressure is shown by the growing of the plate. In fact, most of the plugs that fall out are broken in two at the middle or a little beyond.

This may be partly remedied by increasing the angle at the middle, and instead of straight lines using a flowing curve.

Another disadvantage is the weight of the inactive support — generally considerably greater than that of the active material. In some processes of manufacture small pieces of coke are mixed with the active material to give better circulation. The increased circulation is without doubt an advantage, but the proportion of inactive material is still further increased.

A form of battery plate which has recently come into notice is the "lithanode" element. In this there is no supporting grid. The active material is pressed into a homogeneous plate and is held in a celluloid frame. Contacts are made by platinum strips. I have seen no trustworthy tests of these cells, nor any statements that will allow one to clearly judge of their merits or defects. If on investigation it is shown that the difference between the energy which goes into them and that which comes out is more than can be accounted for by the heating of the cell, then their life is limited, as in the ordinary grid form of plate. The advantages would seem to be greater proportion of active material, and no wasteful local action. In such a plate, however, there seems no possibility of obtaining the circulation which I consider so important without greatly decreasing the strength and conductivity of the plate.

Without going further into the matter, I may say that there are many forms of storage battery, many of them worthless, patented every month.

In some of the batteries now manufactured the supporting grids are made of an alloy of lead, antimony and mercury. The result is to stiffen them, and to partially prevent oxidation. Whether this is an advantage or not seems to me to depend upon how much corrosion actually takes place. The result of local action is to change the lead of the grid into PbO_2 and $PbSO_4$, substances which have less sp. gr. than the lead. The natural result is to cause a pressure through the plate—a pressure which shows itself in the "growth" of the plate. One component of this pressure tends to force out the plugs, as I have said before; but in general the pressure is relieved by the growth of the plate. With a stiff plate, however, such as that made from the lead, antimony, mercury alloy, this growth could hardly take place, and any considerable local action would result in the forcing out of the plugs. Whether this really happens or not I do not know; I am not practically acquainted with the cell.

Coming to the commercial applications of the cell, let us first speak of it as applied to lighting. Here a storage battery has two advantages—it allows the lighting plant to be constantly utilized, instead of only supplying light for a few hours; and it allows long-distance incandescent lighting. I would point out, however, that while the storage battery is being constantly improved and its economy increased, yet at the same time there are two powerful rivals whose improvement and introduction are even more rapid. I refer to electric motors and to long distance systems—for example, the alternating system—of electrical distribution. When the distribution of power from electric lighting stations reaches such a point that the greater part of the available energy is used during the day for motor service, then the first advantage of the storage battery has been largely lost. For long distance incandescent lighting it comes down to a question of economy. Just now I doubt if the storage battery is ahead.

For traction, however, it is different. I think that even in its present state the storage battery is more promising than any other system for street railways where the distance is over one or two miles and the grades do not exceed from 6 to 8 per cent. They will only succeed, however, when proper care is taken in manufacture and maintenance. The storage battery is not so economical that it can afford to neglect even the slighest precaution, in competing with horses or cables; and the difference between success and failure may lie in apparently trifling precautions. A point in which the batteries I have seen are deficient lies in the inability to remove worn-out plates—this can be easily remedied. Another thing that I would recommend is a regular inspection of each cell at stated and not too long intervals.

There is another point, in storage cells the principal deterioration is in the positive plates, and these have frequently to be renewed or repasted. To do this economically there should be in each city where there are street car lines run by storage batteries, facilities for economical renewal; either the street car companies themselves should have the privilege of repasting and manufacturing plates, or there should be a branch factory of the parent battery company. The actual cost of renewing worn-out plates is not great, but if the plates have to be transported to a distance, and then several profits made, the cost will throw the balance against the battery.

To sum up, I think that, even as matters now stand, the lead storage battery is a profitable investment for certain purposes, and there are chances for considerable improvement. With regard to the storage of energy in general by means of the electric current, the possibilities are enormous, and I think that in the near future many of these possibilities will be realized.

DR. MOSES: I would like to ask Dr. Duncan a question or two. Would he kindly tell us the nature of that crystalline deposit? There is a crystalline deposit the Doctor spoke of which covers the lead grid. Is it of a peroxide character? Is it really lead itself?

DR. DUNCAN: I think that that crystalline deposit is peroxide, and I think that the reason it protects the grid is that it is so dense that no acid can get between it and the lead support, and there being no acid between them there can be no local action. In protecting grids of that kind it simply amounts to depositing, before the grid is pasted, a lid of peroxide so hard that no acid can get between it and the plate; but, as I say, I do not think

in the manufacture of plates it is desirable.

MR. PENDLETON: In regard to the action which the Doctor has referred to of covering the plate with a coating of peroxide of lead, I would like to inquire whether the formation of any other salt of lead would not be as efficient for the purpose indicated? I recollect in 1882 in experiments that were made at that time that hydrate of lead was formed on the surface of the smooth lead plate before the plastered oxide was converted into the receptive material, and it had the effect which the Doctor has alluded to in preventing the formation of sulphate or any other salt between the plate and the receptive material. It is only a few months ago that a theory was evolved that the sulphuric acid creeping between the receptive material and the plate caused a local action which was ventilated as being disastrous to the success of the storage battery. I have listened to so many of these theories that I have become somewhat diffident in ventilating experiences of years. I believe that the storage battery has at last arrived at a period when its usefulness can no longer be questioned. I returned from Philadelphia only to-day, where experiments in the matter of street car propulsion have been very successful in every particular. The gentlemen interested expressed themselves convinced of the value and success of the storage battery. They acknowledged that great improvements would be made shortly in the propelling apparatus of the car, yet even as it was, with its faults recognized, they said the results were satisfactory.

DR. MOSES: There is one point, Mr. President, that Dr. Duncan has very properly considered, which is a matter perhaps more of commercial than of scientific importance. The theory of the secondary battery at the present moment is very well understood. The practice of it is also, I may say, well understood, and becoming better understood; but withal there are certain difficulties, to which Dr. Duncan has alluded which underlie the success of all such commercial enterprises—the mechanical difficulties. When we look at the incandescent light, for instance, we find that about seven or eight years ago, when the most serious experiments were begun for the perfection of it, we found all the elements of the light existing, scattered about. But they had not all been collated and improved. Now we know in the secondary battery many defects have been remedied. We know the chemistry of it. We know the possible returns—they have been very accurately determined—and yet withal there is a certain point beyond which we have not advanced or beyond which advance has not been made, simply because the mechanical difficulties that are in the way have prevented. Now Dr. Duncan has called attention to one point in particular, and I think you gentlemen (among whom I notice several inventors) should consider how to perfect the battery in its mechanical devices. When you are dealing with lead—which is, after all, the only material which we can employ for positive and negative plates with any degree of commercial success—when you consider lead you find a metal which, practically speaking has no resilience. You put a pressure on lead and in a few seconds it moves away from the point of pressure; it has a flow like ice under pressure. The very successful lead-covered cables we are daily using prove to us the facility with which lead can be made to flow. The cold lead is pressed by hydraulic pressure and placed around the conductors without injury—taking any shape that may be required. Now, when you are making connections, which after all has to be done in every battery, between every cell of a battery you either employ solder or some system of soldering, or you employ binding pieces to keep your lead plates together. The instant you solder you are setting up a local chemical action that, under the influence of both hydrogen and oxygen, produces a chemical change at the point of junction, tending to dissolve it, and giving you a point of weakness in the battery. The instant you put a pressure on two plates to bring a good contact, that instant the lead begins to flow, and tends to relieve itself of the pressure; so that there you have a radical defect in the present system of coupling up secondary batteries that must be avoided. The method that has been adopted in some of these ingenious forms of putting plates together by coupling them up in series—multiple arc—gives you a very compact form, but at the same time prevents the battery from being really accessible, as Dr. Duncan very properly says—the strength of a chain is its weakest link. The strength of a battery coupled up in that way we have seen is really the weakest place, and as all the plates are weak, as he has shown, at certain points, we have an element of weakness that makes the battery, I might say, almost helpless. The difficulty will come. It is a portion of the great chain of the battery, and any, the smallest weakness in it, affects the whole thing. Therefore it seems to me that the solution of this matter is to come first from your coupling up the battery in such a way as to avoid any metallic contact whatever. That is to say your own plates should be both positive and negative. You may put them in the same solution, side by side, increasing the surface and diminishing the internal resistance of each cell. That may be carried on to an almost unlimited extent. Each pair of plates becomes entirely independent of its neighbor. They may be renewed when deteriorated. They may be removed without very much interfering with the general circulation, and in that way you would be getting nearer to the solution of the question in its practical point. You want to be able, as some of you may recollect I said some time ago in respect to alternating current machines, to box up a negro with the machine and send it off. That is, there being no brushes, the thing would run itself. So with the secondary battery, you want also to be able to box up a negro with it. There must be no galvanometers—no contacts to become defective—nothing in the world but the introducing of a plate into a solution, and that is the end of the matter—no looking after contacts. When that is done the secondary battery is in a fair way of being generally adopted. The second improvement consists in diminishing the thickness of the plate. That has become a very serious difficulty because of the amount of capital that has to be invested and the amount of dead material that has to be carried. In other words, you have to store energy for the purpose of carrying the thing. We all know that if we are going to run races we train down; we take off all the superfluous fat. You have got to take down all the superfluous lead from these grids. None of us ever ran at ten pounds, but we take off all we can; and it is not to be supposed that you will ever wholly get rid of lead. You must have a skeleton of lead running through the whole thing. And therein consists another matter that you have got to consider—not a particle of active material should be in there that is not in active mechanical contact with some other portion of lead. In other words, there has got to be a perfect skeleton of lead throughout your whole cell.

MR. MAILLOUX: Just as the electric light man of ten years ago did not wait for the dynamo of to-day before entering the business of electric lighting, the electric light man or the electrical engineer of to day need not wait for the storage battery of ten years hence in order to begin to do successful work. The dynamo-electric machine and the old Gramme had quite a successful career in certain specific applications, and the storage battery to-day has also spheres of usefulness where it can be almost master of the field. I would call the attention of the members, for instance, to the lighting of private residences which are detached, country residences, summer residences, and large mansions. I believe that there the storage battery has a sphere which it will hold as its own, for the reason that the direct system of to-day does not afford all the requisites of a perfect application of electricity for lighting. It has not supplanted gas, and you will find that wherever isolated plants are in use to-day they still have gas. Now, I do not consider that we can look upon isolated lighting as a success until we see it drive gas out altogether. To do that we must have electricity on tap twenty four hours a day, and I conceive of no system by which it can be done except one involving the use of the storage battery, at least as an accessory, if nothing more.

MR. DECAMP: I have listened to the paper and to the discussion with a great deal of interest. I would say that this is a renewed interest on my part. I got pretty well along on batteries some four years ago, and as one who holds the purse-strings of a cold-blooded corporation who look for definite results, I had to disabuse my mind of all hope of a battery, for the time being. I was honored last night by Prof Reckenzaun, who spent the evening with me, and I had a very interesting talk with him on this subject of batteries, being awakened by his very interesting paper in Boston. But this has occurred to me—I am expected to look after these things and keep abreast of what is going on—and this thing has occurred to me and I mention it as a thing for you to think of. Six years ago, or a little over, when I first took charge of an electric lighting station—and it was among the first that was established—I heard frequently and constantly of the storage battery. It was held out as of great hope for the future. In other words, the storage battery was contemporaneous with the arc light and the incandescent light. How do we stand to day? Both of those elements in electric lighting have long passed beyond the stage of experiment. They are accepted by the public as established facts. As we stand to-day, for practical purposes, regarded as a money-making part of the business, so far as I can see, or so far as I could recommend to the men who hold me responsible, we are no nearer utilizing the storage battery than we were six years ago. Now that to me, is rather discouraging. It is, perhaps, some hing that you, gentlemen, who are taking so deep an interest in this subject of storage batteries do not see to the extent to which it exists. I to-day have control of stations or plants which are capable of supplying to the public, for an average of three hours each day, 50,000 incandescent lights, or current for that purpose, whether it be used for incandescent light or power; and for what? Simply an increased consumption of coal, and the legitimate wear and tear of the machinery. Just think of it! Give me some facilities by which I can say to every man in my employ: You are employed by us for twelve hours a day, not to be idle because one hour demands your activity, that every wheel in my place must turn—must not stand still. Look at the product. The condition of the electric light plants to-day is good. That could not be said a few months ago. I don't know, from my own knowledge, or from inquiry or observation, of any electric light plant to-day that is not returning a fair revenue on its capital. Idle how long of the twenty-four hours? Eighty per cent. is enough. Take a laboring man making his living with eighty per cent. of his time idle. Now, what the lighting stations want is something to utilize that. I venture to say this, that the advantage that you would have by keeping every man in your employ actively engaged would more than pay for the increased consumption of coal and wear and tear, because I find that idle men waste more than active men, by a long way Therefore you might say, taking, perhaps, an extreme view of it, that all the energy that you can store during those idle hours is absolutely clear gain.

MR. PENDLETON: The plain, common sense business test that Mr DeCamp put—will it pay?—is one which should be met with facts. A short time ago in Boston, talking with the manager of the New England Weston Company he made the remark to me that, according to his calculations, to avail of the storage battery plant for electric lighting would entail an investment as great as the dynamo and the lamps, and, therefore, he considered, except in isolated cases that the matter of cost prohibited the storage battery coming into use If a man was running 300 lamps in any locality, and wished to use a few lamps overtime, the storage battery in connection with electric light there has a use. But to attempt to run a plant of 300 lamps by this storage battery system he considered—and I must acknowledge I agreed with him—that the cost was so great that it never could come into any use. Besides this matter of expense there is a characteristic of the storage battery in connection with incandescent lighting—it has a necessarily complicated outfit. As the battery falls in potential the resistance of the light rises, and you are obliged to supplement the ordinary battery with cells cut in as the potential falls. There is another objection I realize as inherent to the accumulator in connection with electric lighting; but in the matter of using the storage battery with the electric motor, and in all the applications for power, you will not find such objection, and it is in that line only, I believe, that the battery will have a great future.

MR. DECAMP: I do not look upon the storage battery as simply—if you will allow the expression—the tail of the dog. I think my views would be rather the other way; I should be more disposed to regard it as the dog wagging the tail There is no case, if my recollection serves me right, where the companies that I represent have arc lights that are not incapable of being displaced by any system of incandescent lighting. We have no customers of the kind which do not require a given amount of light. No arc station can supply both wants, because the use of the one conflicts with the other. Take, if you please, a circuit of sixty lights among ten, fifteen or twenty different people, all of whom want arc lights, all of whom want incandescent lights—there is no reason why that machine should stop when they cease to need arc lights; it might just as well go on It is what it is there for: the money is in it; the interest does not stop. The man who stands over your engine or over your dynamo is impregnable to the argument that because that machine stops his pay shall stop. It goes right straight along all the time. Let it go. Let its energy go into something else where it is kept in check until it can be sold. That is the point, and that is the only point.

MR. PENDLETON: There is only one system to-day using over 20 amperes of current—the Weston United States system. I believe all other systems have been gradually cutting down the amperes until they aim now to run as low as seven or seven and a half amperes of current. Take the station which I had the pleasure of inspecting yesterday, of the Brush Light Company, of Philadelphia. I saw the machines there—I believe they are sixty light machines—giving about 2,400 volts on the circuit. Now, that would require 1,200 accumulators in circuit fed at a low rate, and the magnitude of that plant I think would strike Mr. DeCamp as being rather excessive for the use of storing the energy that the dynamo might make—1,200 accumulators receiving seven or eight or nine amperes during the hours of idleness. It seemed to me that it would be almost impossible to unite the accumulator system to the arc light system of to-day.

MR. DECAMP: I cannot answer that question any further than this—it is true that we cannot utilize those machines—being 10 ampere machines for instance—to the same advantage on the storage battery as we could if there was 40 amperes, but we can utilize them to the extent of 10 amperes, which is just that much better than we can do now. Here is a battery that is called a five hour battery, but to make it a five hour battery it takes twenty hours with a 10-ampere current to charge it. We cannot spare that machine for twenty hours. We can spare it for ten hours. That makes our battery a two and a half hour battery instead of a five hour battery. The question is does that fill the bill? I do not know whether it does or not. That was remedied by simply putting adjustment on the armature, by means of which in less than half a minute it was converted into a twenty ampere current instead of a ten ampere current.

MR. PENDLETON: I would state that while speaking of the station as I saw it, my remarks applied solely to the facts that were presented; but while Mr. DeCamp was speaking it suggested itself very readily that a commutation might be very easily made by uniting the dynamos themselves in multiples, which can be done very readily to-day by means of a current-breaker where there is no danger of one dynamo running the other as a motor, which has been the difficulty here ofore, as we remember at the first opening of the Edison Station in Pearl street. The apparatus is already in existence to combine any number of dynamos, and in that way the accumulator may be made to receive forty or fifty amperes. But I was merely speaking of the station as I saw and of the apparatus as now running.

MR. DECAMP: All that I know is this: On an average right straight through with a plant covering 800 lights, for eighteen hours out of the twenty-four we are making absolutely no use of the opportunities which lie before us I do not care whether the current is for incandescent lighting or for power. We use it both ways But that is a fact, nevertheless, and I believe it applies to all arc light stations

DR. MOSES: I would like to fire one little parting shot if you would permit me, by recalling to your memory—because it is a very familiar anecdote—that Irishman that came to this country having been told that it was a country where you could pick up twenty dollar gold pieces with the greatest ease. On walking up Broadway he picked up a five dollar gold piece, and, throwing it away contemptuously he said: "I will wait until I can pick up twenty dollar gold pieces." Here you have an electric light plant, and for about eighteen hours a day it is perfectly idle. If you can get the use of boilers, engines, dynamos, labor, capital, safe business, prestige—if you can get all those things for nothing and cannot use a storage battery and make it pay, I say you better give up the storage battery.

On motion of Mr. Dutton a vote of thanks was tendered to Dr. Duncan, for his valuable paper, and the club adjourned.

An amendment to the Constitution and By Laws, proposed by Mr. C. O. Baker, jr., in which the Board of Managers is empowered to fill all vacancies that may occur in committees, was adopted prior to the presentation of the paper. The Electrical Accumulator Company, of 44 Broadway, kindly loaned the club a storage battery cell and several plates, which were used by Dr. Duncan in illustrating his paper.

ELECTRIC LIGHT NEWS

—— Fergus Falls (Minn) Electric Light and Power Company has been organized, with a capital stock of $15,000. Incorporators, James Compton, Andrew Erwin, F. G. Barrows, Chas L. Lewis.

—— The Dixon Manufacturing Company, of Scranton, Pa., which has been using the Brush-Swan system for the past seven years, has just given an order to the Brush Swan Company to double the capacity of their electric plant.

—— The contract for lighting the principal wharves in Pittsburgh, Pa., has been awarded to the Allegheny County Light Company. The company is to furnish twenty 2,000-candle power arcs, receiving therefor $180 each per annum.

—— The contract has been made with a Bridgeport party to build the dam for the Electric Light Company, Robertsville Falls where the company will put up a building with a 240 horse power turbine water wheel to run the dynamos.

—— The Coffeyville Electric Light and Power Company, of Coffeyville, Kan., has been incorporated. Messrs. Edward L. Foster, of Independence, H. H. Upham, William McCoy, William T. Read, George Slosson, and others, of Coffeyville, are corporators.

—— The Elmira Illuminating Company of Elmira, N. Y., has been incorporated, with a capital stock of $200 000, and Messrs. J. M. Shoemaker, J. B. Stanchfield, J. A. Reynolds, W. M. Clark and others, as corporators. The company intends to furnish gas and electricity.

—— The Ashtabula Water Works Company, of Ashtabula, Ohio, will add electric lights to their water works business. They have commenced by ordering sixty lights from the American Electric Manufacturing Company, which they expect to increase considerably during the coming fall.

—— The streets of Joliet, Ill., are to be lighted entirely by the American system of electric lighting in place of gas and oil lamps. The present electric plant is to be entirely overhauled and 200 new lights added to it immediately. It is said that it will be one of the finest electric light stations in the West when completed.

—— In the office of the sub-editor of this journal, says the Toronto, Ont., *Globe*, is a 32-candle Edison lamp which has been burning full power five hours every night, six nights a week, ever since the installation of the system in November, 1884. The lamp was guaranteed for 600 hours, but is still burning with undiminished power after more than 4,700 hours' service.

—— At a special election, held on Aug. 8, by the taxpayers of the town of Canastota, N. Y., for the purpose of determining whether or not the sum of $2,000 should be raised by special tax for lighting the streets by electricity during the ensuing year, 166 votes were polled. A count proved that 83 were in favor of the project, while an equal number opposed the plan. Another ballot has been ordered.

—— The National Machinery Company, of Denver, Col., is quite active in the electric lighting business. A new electric lighting company is being organized in Denver, to use the American system of electric lighting. Fifty lights have just been ordered, and it is expected that this will be added to considerably within the next few weeks. The electric light business in Denver up to the present time has been done by the Brush and Edison systems.

—— Electric lanterns, will, it is thought, take the place in course of time of the ordinary mining safety lamps. A portable electric lamp can now be made, possessing the following features: Weight, about three pounds; illuminating power, five candles; size and shape, similar to present lamps; duration of light, ten hours; cost of repairs, charges of battery and materials, two cents for ten hours; these facts showing that there is nothing to prevent its adoption as a substitute for the present lamps, and even for candles in many mines where they are still in use.

—— The city of Bath, Me., has just entered the list of cities to be illuminated by electric light. Last week the common council passed a vote almost unanimously authorizing the mayor to contract for five years with the American Company for lighting the streets. The Bath Electric Light and Power Company has been organized with Mr. F. A. Sawyer, of Portland, president, and Mr. Fritz Twitchell, of Bath, treasurer. The work has commenced, and the plant will be in operation sometime during the month of September.

—— The annual meeting of the stockholders of the Newburgh Electric Lighting Company was held at the office of the company Wednesday last, at which the following trustees were elected: Edward W. Wilson, George A. Sanford, A. V. Wiltsie, John W. Pollock, Wm. F. Cameron. The report of the president and treasurer were presented, and showed a marked increase in the business of the company for the last year. The trustees elected the following officers: President, E. W. Wilson; secretary and treasurer, A. V. Wiltsie; general manager, Ed. R. Hasbrouck; executive committee, Ed. W. Wilson, A. V. Wiltsie, W. F. Cameron. A dividend of three and one-half per cent. upon the capital stock was declared by the trustees.

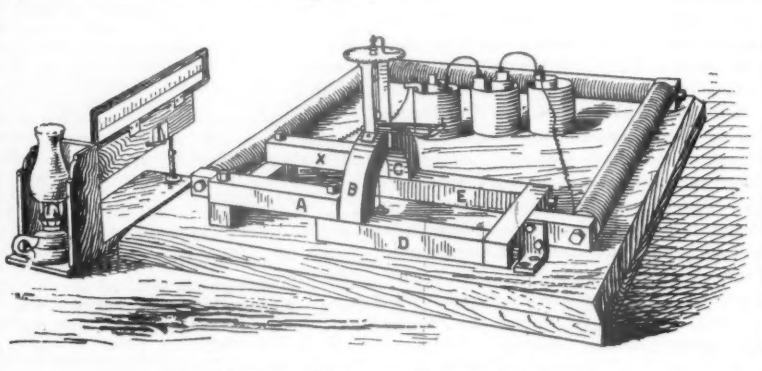
—— The Markle Engineering Company, of Detroit, Mich., agents for the Edison Electric Company and the American Electric Manufacturing Company, of New York, have been competing very strongly for the contract for lighting the city of Marquette, Mich. The contract has been awarded them, and the Edison Illuminating Company have ordered a 50 light American apparatus to light the public streets of the city. The Markle Engineering Company report several other orders in progress for American apparatus.

—— The Edison Electrical Illuminating Company has procured an order to show cause why a mandamus should not issue to compel the Electrical Subway Commission of Brooklyn to grant it permission to tear up, for the purpose of laying wires, the following streets: Fulton street, from Sands street to Flatbush avenue; Court street, from Fulton street to Atlantic avenue; Atlantic avenue, from Furman street to Court street; from Fulton street to Columbia Heights, through Montague, Henry, Clark, Pineapple and Orange streets; from Fulton street to Atlantic avenue, through Clinton, Henry, Hicks and Willow streets; to Columbia Heights, from Court street, through Remsen or Joralemon streets.

The Commission has already granted permission to lay wires through these streets, but it declines to give leave to tear up the roadway, and is desirous that the court should construe the law and decide whether it has any right thereunder to give the permission demanded.

Edison's Magnetic Bridge.

In this invention by Mr. T. A. Edison an electro-magnet is placed in circuit with two or three cells. In the illustration which appears herewith, the lines of force, if *A* and *X*, *D* and *E*, all of iron and placed between the poles of the electro-magnet, are of the same magnetic resistance, will be parallel to these pieces, and a small magnetic needle carrying a mirror and pointer will be set parallel to the lines of force when hung between the circular iron projections *B C*, and will therefore be considered at zero. If however, *X* is a piece of metal the magnetic conductivity of which is to be measured unless *A* have the same magnetic resistance as *X*, the lines of force will no longer be at right angles to *B C* and the suspended needle no longer point to zero. Pieces of soft iron are put in place of *A* until the needle points to zero, when *A* and *X* have equal magnetic conductivity. The apparatus is merely experimental and can be made much more elaborately. It has been used to test iron for dynamos. It is suggested that it also be used to test iron for machinery and bridges for flaws. The errors in this apparatus are exactly the same as would occur in measuring low resistances by a Wheatstone's Bridge, the entire apparatus being immersed in salt water. Another source of error is the residual magnetism of the iron. Therefore before taking a measurement the bent arms *B* and *C* are freed from magnetism when the needle returns to zero. By calibration it is possible to make measurements by the deflection of the pointer by the number of degrees the torsion head must be turned to bring the pointer to zero. It is an interesting fact that the instrument shows that some specimens of cast iron have $2\frac{1}{2}$ times the magnetic resistance of the best Norway iron. For standards in measuring, bars made of iron reduced by hydrogen might be used.



THE MAGNETIC BRIDGE OF THOMAS A. EDISON.

The Messenger Boy Record Beaten.

The rural life led by Daniel Frohman during the summer in his Stamford farm has, remarks the *Tribune*, induced habits of early rising, so that long before 7 A. M. last Friday he was on the pier waiting for the arrival of the Germanic. He was there to meet Eugene Sanger, messenger boy No. 1,222, who was sent over by Mr. Sothern and himself to deliver the fiftieth night souvenirs of "The Highest Bidder." At 11 o'clock young Sanger received his friends and their congratulations at the Lyceum Theater. The boy was absent just twenty-three days, during which he traveled nearly 7,000 miles, which, it is admitted, breaks into small pieces the messenger boy record, the highest speed hitherto attained being twenty-three miles in 7,000 days, or thereabouts. He brought back with him the special delivery tickets signed by those to whom he delivered the packages. His arrest was not a painful affair, but Mr. Overton, who acted as Mr. Frohman's representative, was told by the authorities that the boy must not deliver any private letters. This occasioned a detention of some hours until the affair was straightened out.

The boy himself, who is a bright, intelligent youngster, spoke of his trip with glee. While in London he had a thoroughly good time, marred only by the untoward circumstance of his being charged sixpence for a programme at one of the theaters. He was the more mortified as he thought he had made a favorable impression on the young woman who so taxed him, and attributed her lingering near him to other motives than the desire to get a miserable coin. On the voyage home he captured the entire ship, winning three prizes in the athletic contests arranged by the passengers, and giving an entertainment of imitations and songs in the saloon alone and unaided. It appears that he has already had some stage experience, and Mr. Frohman is going to utilize him by giving him small parts in the Lyceum Theater Company. His mother gave her consent to this.

A Method of Comparing Galvanometer Coils.

BY J. J. SKINNER, PH. D.

(Abstract of Paper presented at the late meeting of the American Association for Advancement of Science.)

The method consists in fastening rigidly together the two coils to be compared, so as to be concentric and to have their assumed mean planes as nearly as possible coincident. A magnet needle is suspended in the common axis of the coils at a measured distance from the mean plane, and a resistance is introduced into the circuit of one of the coils, of such an amount as to leave the needle at rest when a divided current flows in opposite directions in the two coils. The resistances of the circuits of the two coils are immediately measured, and thus the ratio of the currents in them determined. To eliminate errors in estimating what is supposed to be the position of the mean planes of the coils, and lack of symmetry of winding, a reversal of the rigidly connected coils is made, keeping the distance from the needle the same, or else the needle is supported first on one side of the coils and then on the other at equal distances. The point of reference from which to measure these distances may be a pair of threads attached to the smaller of the two coils and crossing at its center.

Assume the following notation:

R and r denote the respective mean radii of the two coils.

N and n denote the respective numbers of turns of wire on the coils.

C and c denote the respective currents in the coils in the first position.

C' and c' denote the respective currents in the coils in the second position.

e denotes the distance from the cross threads to the needle.

x and y denote the respective small and unknown distances from the cross threads to the true mean planes of the two coils.

Q and q the respective force-corrections due to the sections of the coils.

Then the following formulas are true with sufficient approximation:

$$\pi r^2 n = \frac{\frac{C}{c}+\frac{C'}{c'}}{2}\cdot \pi R^2 N \frac{(e^2+r^2)^{\frac{3}{2}}}{(e^2+R^2)^{\frac{3}{2}}}$$

$$\left\{1-\frac{3}{2}\cdot\frac{x^2}{e^2+R^2}-\frac{5}{2}\cdot\frac{e^2x^2}{(e^2+R^2)^2}\right.$$

$$+\frac{3}{2}\cdot\frac{y^2}{e^2+r^2}+\frac{3}{2}\cdot\frac{e^2y^2}{(e^2+R^2)^2}+$$

$$\left.\frac{9e^2\times 7}{(e^2+R^2)(e^2+r^2)}\right\}\cdot\frac{Q}{q} \quad (9)$$

$$\frac{C}{c}-\frac{C'}{c'}=\frac{6e\,r^2\,n\,(e^2+R^2)^{\frac{5}{2}}}{R^2\,N\,(e^2+r^2)^2}$$

$$\left\{\frac{x}{e^2+R^2}-\frac{y}{e^2+r^2}\right\}\cdot\frac{q}{Q} \quad (10)$$

If $2b$ denote the breadth, and $2d$ the depth of a rectangular coil-section, whose mean radius is r, the value of the force-correction factor is

$$q=1+\frac{d^2}{3}\left(\frac{1}{r^2}-\frac{15\,e^2}{2\,(r^2+e^2)^2}\right)$$

$$+\frac{b^2\,(4\,e^2-r^2)}{2\,(r^2+e^2)^2} \quad (12)$$

and a similar expression gives the value of Q.

If no very great degree of accuracy is required, the values of x and y in equation (9) may be assumed to be zero, and the equation simplified accordingly. Where greater accuracy is required, two or more complete sets of observations are made, with different values of e, and the ratios of the currents for each set substituted successively in the left hand member of equation (10). These substitutions give two or more equations of the first degree in x and y, and the values of x and y are thus determined.

If the object of the comparison of the coils be to determine the unknown constant of one from the known constant of the other, we assume, say that R and N are known, and if n is unknown and r can be measured approximately, we can get the wave of $\pi r^2 n$ very closely from equation (9.) For by taking a rather large value of e, a slight change in r will have a small effect on the right hand member of that equation. To find x and y from equation (10) we may use an approximate value of $r^2 n$ found from equation (9) by disregarding the factor containing x and y.

The paper discusses the best conditions for the experiment, and gives the results of several series of observations.

The Eickemeyer Magnetic Bridge.

To the Editor of Electrical Review:

Some years ago, while experimenting with an electric machine in which the armature was directly polarized by a circumferential helix, I discovered that by a change in the magnetic connection between the cheeks of the machine I could balance the currents produced by different parts of the armature.

I had, in fact, a magnetic bridge in which the branches balanced each other when the bars of iron which completed the magnetic circuit were of equal cross-section.

This action of the machine attracted my attention at the time, but as it had no bearing upon the subject I was then investigating, I did not pursue it any further.

When later on the question of the relative values of the iron to be used in dynamos presented itself, I used this little machine successfully to determine their values.

On the 25th of May of the current year I sent a communication to Professor Wm. A. Anthony, giving him a full report of my experiments with this bridge, and also sketches and descriptions of the instrument in its original form, as well as suggestions of the changes I proposed to make to simplify it.

Professor Anthony has informed me since, that he constructed an instrument on the design as communicated by me, and used it successfully in the laboratory of Cornell University.

Some little time later, when you called at our factory, I showed you my bridge, and informed you that it was to form the subject of a paper to be read before the Electric Club.

The paper I send you herewith has been prepared for that purpose. It was originally my intention not to publish anything on the subject until after the paper had been read to the Electric Club on one of the first meetings which take place in New York.

Hearing, however, that Mr. T. A. Edison has recently presented a paper on the same subject to the Society for the Advancement of Science, it seems advisable that I should not delay publication any longer, taking into consideration that by this time my invention has probably become known to a number of people, and I would therefore request you to publish the paper I send you herewith, as it was originally prepared.

Yours truly,

R. EICKEMEYER.

Yonkers, N. Y., August 18, 1887.

Mr. President and Gentlemen: Some time ago I had the honor to read to you a paper describing a new form of dynamo machine of my construction.

The discussion which followed brought out a number of questions, and, among others, some remarks about the efficiency of magnets.

I stated then that I did not know the mathematical formula for my electro-magnet, but that I hoped some day to find a way of solving some of the problems that presented themselves.

This evening I have the pleasure to show you an instrument which is of some use in that direction.

After I had perfected my dynamo machine, and made it, as I think, a good machine, electrically as well as mechanically, the question as to the best material for its construction was to be considered.

Now, the text books state that cast-iron is about 50 per cent. of wrought-iron, magnetically; but what were the relative values of the different kinds of cast-iron which I had at my command?

I know, of course, that, with a magnetometer and a complete set of instruments, this question could be answered; but as I had no such instruments, and, in fact, no time to make elaborate tests, I set out to devise some means of solving the question in a simple way.

The result is the instrument before you.

The object I had in view was to measure the permeability of a given piece of metal for magnetic lines of force, or rather to determine its conductivity for the magnetic current.

It would take too much time to give you a history of the instrument, as it is the result of a good many experiments, made in many directions.

The action of the instrument is based on substantially the same principles as the Wheatstone bridge; but instead of the two electric circuits of the latter, I make use of two magnetic circuits.

The two magnetic circuits, when balanced, produce no effect upon the indicator needle; but when there is a greater magnetic resistance in one branch than in the other the needle is deflected.

I will now proceed to describe the instrument in detail.

Fig. 1.

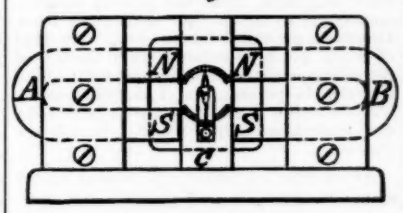


Fig. 1 represents an instrument of the simplest form.

The magnetic bridge is composed of two horseshoe magnets, *A* and *B*, which are clamped on an upright piece of wood, with their two poles of like denomination facing

Fig. 2.

each other. In the center, between the four poles, I have mounted a small soft iron indicator needle provided with a pointer and a scale, which, for convenience of comparison, is divided into degrees.

Fig. 3.

To explain the operation of the instrument, I have prepared two diagrams, Figs. 2 and 3.

The lines of force from the magnets run from pole to pole, but where the lines of force of the magnets come in contact with each other a straight line is formed.

It is evident that a short needle of soft

Fig. 4.

iron or steel will set itself in this line, which, for convenience, we will call the zero line, and the corresponding mark on the scale zero.

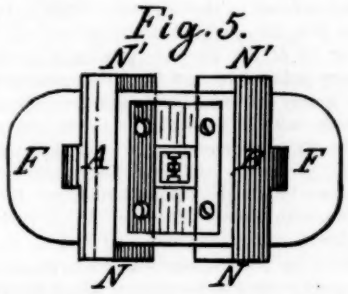
In Fig. 3 I have shown the two magnets as before, but I have placed a piece of iron *D* diagonally from the *N* pole of magnet *A* to the *S* pole of magnet *B*.

In the first sketch the lines of force of both magnets had to complete their circuit through the air, but now some of the lines of force pass from the *N* pole of *A* through the piece of iron *D* to the *S* pole of *B*, while the open poles have to complete their circuit through the air as before.

If we now put a card-board over the magnets again, we find that the lines of force arrange the filings substantially as shown in Fig. 3, and the needle, following the direction of the lines of force, will now assume a position along the line *x y*.

To bring the needle to zero the two free poles have to be connected with a piece of the same conductivity. We thus have a

Fig. 5.



simple device to compare different pieces of metal.

Let us suppose we have two pieces of iron of the same cross-section, both fitting nicely upon the sides of the poles of the magnets; if then we find when both are placed on the poles, the one connecting the *N* pole of *A* with the *S* pole of *B*, and the other one connecting the remaining poles, viz: the *S* pole of *A* with the *N* pole of *B*, that the needle remains at rest, we know that the two pieces of iron carry the same quantity of magnetic current or lines of force.

Should the needle, however, still be deflected to the right, we would know that the piece of iron which connects the *N* pole of *A* with the *S* pole of *B* is the better conductor of the two, and the extent of this deflection would form a means to measure the difference in value of their magnetic conductivity.

But there are other means of comparison Suppose we have a number of pieces of iron of known cross-section, and we add to the bad conductor until the needle returns to zero, then the pieces added will represent the difference between the two conductors.

In Figs. 4 and 5 I have shown another instrument; here the branches of the bridge are electro-magnets.

Fig. 4 is a front view of the instrument with the exciting coil shown in cross-section, and Fig. 5 is a top view.

Two pieces of soft iron *A* and *B*, which form each a little more than ¼ of a circle, are so shaped as to present projecting surfaces or pole faces on the sides of the instrument as at *N S* and *N S* in the front, and *N' S'* and *N' S'* on the opposite side.

The pieces of iron are connected with each other by two corner pieces *D* and *E* of diamagnetic metal, and around the central part an exciting helix *F*, like an ordinary galvanometer coil, is wound.

A small soft iron needle *C* is mounted in the center, and its pointer marks the zero point, when the instrument is excited by a current.

The four faces on each side are in one plane, to form the pole faces upon which the material to be tested is placed.

This instrument is used like the one above. If two pieces of iron or other material are to be compared with each other, the one is placed on two poles diagonally opposite each other on one side, and the other on the two free poles diagonally opposite each other on the other side. The position of the needle on the scale furnishes a means to measure the difference as before.

But the instrument also furnishes the means to compare different materials under different magnetic conditions.

Suppose we excite the instrument with a small current and compare two pieces of iron, and we find the needle is deflected; we then add conducting material to the side which offers the greatest resistance to the magnetic current until the needle returns to zero. We now increase the current and find that the needle is again deflected; we know then that the conductivity of the two pieces does not remain equal when the magnetic potential is increased.

For all practical purposes the last instrument seems to be all that is required.

If we take soft Norway iron as a standard we can find the relative values in regard to magnetic conductivity of any other kind of iron. We may compare them under all the conditions in which they are to be used, as we are able by the use of currents of the required E.M.F. to bring the magnetic potential of the instrument to any point desired.

For more delicate comparisons, however, I have designed an instrument in which the differences can be multiplied indefinitely.

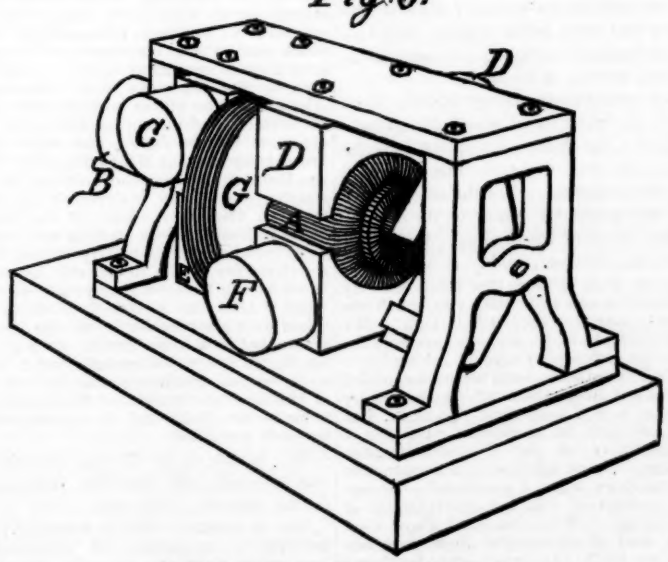
Fig. 6 represents such an instrument. For the needle here is substituted a rotating armature *A* of the Von Hefner-Alteneck type.

This armature is mounted in a frame of diamagnetic metal. It is rotated by means of a belt on the pulley *B*, and its commutator brushes are put in circuit with a galvanometer. To the brass frame I have fastened four iron cheek pieces *C D E* and *F;* these cheeks are closely fitted to the armature, and each is provided with a cylindrical projection, *C* and *F* on the side seen in the figure and *D* and *E* on the opposite side.

Circumferentially and around the middle of the armature I have wound an exciting coil *G*. When the armature is excited by the coil the two ends of the armature are polarized, one end will be an *N* and the other an *S* pole. The rotation of the armature will, under this condition, produce no current; the lines of force passing from end to end around the coil *G* are cut in the same direction by the armature coils, and the galvanometer needle will remain at zero.

When a magnetic conductor is placed upon two of the cheeks diagonally opposite each other, this system is, however, completely

Fig. 6.



THE EICKEMEYER MAGNETIC BRIDGE.

As stated above, the respective *N* and *S* poles of the magnets face each other. If a card-board be placed over the magnets and iron filings sprinkled upon it, the lines of force will arrange the filings substantially as shown by the dotted lines in the figure.

changed. If the conductor be placed upon the projections of the cheeks *C* and *F* in front, a current will be produced by the rotation of the armature, and this current will cause the needle of the galvanometer to be deflected. A part of the magnetic current, which had completed its circuit in the air will now pass from the armature core to the cheek *C*, through the conductor to the cheek *E*, from the cheek *E* to the other end of the armature, and complete its circuit through the armature to the starting point on the other end.

All the lines of force which pass through the conductor are cut by the armature, in one direction on the upper side and in the opposite direction on the lower side, and it is evident that any desired deflection of the galvanometer may be produced by suitable winding of the armature.

To return the galvanometer needle to zero a conductor of equal conductivity has to be placed upon the projections of the remaining cheeks *D E*, when the current produced by the lines of force connecting the two cheeks in front is exactly balanced by the current produced in the armature by the lines of force which pass through the conductor which connects the other two.

With an instrument of this type I have been able to measure differences of no more than $\frac{1}{2}$ of one per cent., I have been able to select from different cast and wrought irons that which in its magnetic permeability and conductivity came nearest to the best Norway iron. I have been able to measure the difference in the resistance of two pieces of iron of the same cross-section and permeability, but of different lengths, and I have no doubt that by the use of an instrument of this type, many of the questions which present themselves to the practical electrician as well as to the scientific investigator can be readily answered.

But the use of the magnetic bridge does not seem to end with the determination of magnetic permeability or magnetic resistance. I have found that the E.M.F. of the current which excites the instrument can be measured by the cross-section of the magnetic conductor, which, under certain conditions, balances the current. I am inclined to think that the principle involved will be applicable to construct instruments for electric measurements as well.

This branch of the subject I have, however, not yet fully explored, and I reserve it for another occasion should the experiments which are now being made lead to the expected successful results.

Non-Magnetic Watches.

When a man carrying a fine watch loses his train by reason of his watch having "gone wrong," thereby causing him much annoyance and vexatious trouble, he naturally takes a deep intetest in an invention which is a preventive against such occurrences, and this is the reason why the exhibit made by the Geneva Non-Magnetic Watch Company, of New York, of their non-magnetic watches, at the National Electric Light Convention, attracted so much attention from the members of the convention as well as visiting scientists. These non-magnetic qualities lie wholly in the movement, as the balance and hair spring are made of alloys which are entirely exempt from magnetic influences, and as these are the governors of time no amount of magnetism in any other part of the watch would disturb its time-keeping qualities. Many interesting experiments were made showing that the balance and hair spring were free from magnetic influence, among them a compensation balance, such as used in other watches, was floated in water in a glass a three inch horseshoe magnet was then held within 18 or 20 inches, and the balance was immediately attracted, following the magnet in all directions; one of the balances used in the watches of the Geneva Non-Magnetic Watch Company and the invention of C. A. Paillard, of Geneva, was next floated on the water in the same manner, and a 12 inch compound magnet held directly on the glass failed to cause the least disturbance, proving beyond a doubt that the balance was exempt from magnetic influences. A test made in the exhibit rooms of the Thomson-Houston Electric Light Company on a powerful magnet whose attractive force was so great as to hold a piece of iron so tightly that it required great strength to remove, proved the freeness of the balance from magnetism by it dropping on the magnet as a penny would on a piece of glass.

This invention has met a long-felt want among those whose occupation takes them among dynamos or other electrical appliances as well as by the public, and as the use of all makeshifts are dispensed with, these movements fitting regular cases, they would seem to be the watch of the future.

The Electric Light Banquet.

THE BOAT-RIDE, VISIT TO THE THOMSON-HOUSTON FACTORY, AND THE BANQUET AT POINT OF PINES.

From 12.30 P. M. August 10, until 12 30 A. M. the next day—or possibly later—the members of the National Electric Light Association enjoyed an hospitality never surpassed. There was not a single drawback. The weather was perfect and the entertainment lavish and comprehensively delightful. In accordance with announcements so carefully and thoroughly made that none went astray, the attendants assembled on Tremont street, were carried to the ferry on chartered street cars, and placed in one of the city's large boats, enjoying a ride down the bay to Nahant, stopping at Deer Island long enough to visit the admirably managed Institute of Correction and partake of a superb lunch provided by the city of Boston through its most generous mayor, Hugh O'Brien. The chapel of the Institute was visited, and excellent singing and music rendered by the little boys confined therein. A talk to the boys was given by Dr. Moses, in which he most kindly and appropriately alluded to the sturdy, forceful looks of the little fellows, and, by apt illustration, pointed the way for them to become strong, honest and successful men. This little speech, in its appropriateness and beauty was a gem, and the Doctor's versatility in this respect never appeared to better advantage.

From Nahant the visitors enjoyed a delightful ride to the large works of the Thomson-Houston Company in carriages and barges, and passed through the great factory in companies under the guidance of the officers and staff of the company. This part of the programme was skillfully carried out, so that all of the 250 were privileged to visit every point of interest in this establishment of nearly 800 employes, under a competent guide, without crowding or inconvenience. The REVIEW representative was placed under particular obligations for courtesies shown by Messrs. Coffin, Barton, and Rice, who, with Messrs. Morrison, W. F. Swift, Gilbert, Ridlon, DeCamp, and Wright, comprised one party of tourists. Prof. Thomson was discovered in his pleasant offices warmly greeting all comers, and the fact came out that several gentlemen present had known him years ago, whose only regrets now were that the acquaintance had not been more assiduously cultivated. Electric welding was seen in operation, and some were privileged to carry away samples of this most ingenious and successful process.

A special train conveyed the visitors to Point of Pines—the Manhattan Beach of Boston, only it possesses what our beach does not, a great many beautiful, wide-spreading shade trees—and at 7 o'clock two hundred and forty-seven persons filed into the large dining room to enjoy a banquet in every way worthy of the name.

The president of the Boston Electric Club—under the auspices of which wide-awake organization the charming hospitality of the Thomson-Houston Company was dispensed—Mr. Frank Ridlon, called the assembly to order, and called Dr. Moses to the chair as presiding officer of the evening. Dr. Moses, in assuming the chair, said:

It gives me a pleasure that I can scarcely express, to be able to be with you, much less to preside over your festivities to-night. We are assembled to-night, and we have seen the end, as the philosopher says, of a long life—a day is a life to some—and we are assembled to partake of hospitalities which beautifully culminate a well-spent day. To-night, gentlemen, we have the pleasure of partaking of the hospitality of the Thomson-Houston Company. (Loud applause.) I happened to be down-stairs when I overheard some one say to another—I will not individualize or particularize—"Why, you don't know what a cart load of champagne there is somewhere on ice." (Applause and laughter.) I think that that in itself carries in it a certain solution of this question. We are ending the day happily, and we owe it to this lavish hospitality of the Thomson-Houston Company, and also to the kindness of the city of Boston, who have contributed towards this. Gentlemen, it is asking a great deal of you when you are about to partake of a feast and seated at the table and making ready, the juices of the body being elaborated, for me to ask you to rise and give three cheers for the Thomson-Houston Company and the city of Boston, our hosts.

The cheers were given with a right good will, followed with a "tiger."

During the interim between the claret-punch and plover, the chairman called on Prof. Elihu Thomson, "a man and a name we all delight to honor," who was greeted with great applause, and who said:

Gentlemen, I assure you that this is an entirely unexpected honor, for me to be called upon to say anything to you to-night. It gives me great pleasure to meet you upon such an occasion. I hope that it will be only the beginning of a long series of such pleasures in the future. I will say that I knew very little about the present arrangements, and to myself they were news when Dr. Moses presented them to you. My field of work has been rather more in the line of the development of electrical apparatus than speaking in public; and I therefore must with these few remarks, beg your pardon for not continuing any further. (Loud applause.)

As the banquet, so far as it related to the elaborate *menu*, neared its end, the chairman, with agreeable and appropriate words, called out the speakers, the next one being Col. Ransom, of *Modern Light and Heat*, who spoke earnestly of the advance of electrical work.

COL RANSOM: Gentlemen, under such conditions, and with such gentlemen present as are here to-night, no man who is human could stand upon his feet without being filled with thoughts that it would be impossible adequately to utter. From Lake Superior to the Gulf, and from Maine to California the electricians of the United States are assembled in the persons of their most fitting representatives within these four walls to-night.

And what are the electrical interests which you gentlemen represent? What do we, any of us, know to-day about electricity? All we knew about it a few years ago was the battery and the lightning which flashed from the heavens Come to our convention at the Parker House, and there something at least of the answer to this question can now be furnished. There we may witness evidences of the vast and rapid and grand improvements that have been made in theoretical and practical electric science within these past few years. There we may see the results that have been achieved by the Baxter Motor, the Cleveland Motor, and the Edgerton Motor, the Thomson-Houston and other systems of electric lighting. These are among the improvements that have been made within a very brief period When we contemplate these achievements we may imagine something at least of what will be accomplished within the next six months, or at most within the next few years.

The electric light industry now commands the services of very many of the best men and the most intelligent men that this country contains within its borders. And these men are engaged in this business and they are in it to stay. They are not going to retire from the field With such men as Mr. Ridlon, whose superior judgment, suavity and intelligent work command the respect of all who know him; with such men as J. F. Morrison, whose energy, whose pluck and whose determination to succeed are certain to command success; with such men as the sagacious and whole-souled Alexander, who knows no such word as fail; the versatile and incomparable Slattery, who conquers by his logic; and with such a broad-gauge man as Mr. Coffin of the Thomson-Houston system, who occupies the same relative position in his specialty as did the late Col. Thomas A. Scott of the Pennsylvania railroad, whose wisdom and sagacity were nowhere more clearly shown than in the character of the lieutenants he secured to aid him in his great enterprises—is it any wonder that the electrical interests have taken such giant strides in all the improvements that look to perfection, as a result of intelligent and well-directed effort? I want to say to you, gentlemen, that the best talent of the electrical interest of this country will come to the front, and in coming will be properly rewarded.

The health of the Boston Electric Club was proposed, and President Ridlon called on Mr. Slattery to respond:

MR. SLATTERY: While listening to the brilliant corruscations of electrical wit emanating from our versatile friend, Dr. Moses, whose remarks are always appropriate to the occasion, I also was reminded of something which I once read. Charles Dickens, whose name is familiar to most of us, was up on a visit at one time to a certain English lord's house in England, close to Birmingham, the great center of metal-workers in England. The people of the neighboring towns got to know that Charles Dickens was at this particular house on a visit, and they flocked out to see if it were possible to get a sight of him or to hear him speak. His lordship, hearing that. and seeing a great crowd of people before his dwelling, said to Charles Dickens, "You have got to address these people; you have got to speak to them." "Well, my lord," said Dickens, "What shall I say?" "That I do not know," said his lordship; but if he had only known of Dr. Moses at that time, he would have said, "No matter what you say, it will be appropriate to the occasion." But he did not, and so he left Charles Dickens to his discretion, for a comparison, and Dickens said, "Ye sons of iron, brass, copper and steel. who have neither heads to think nor hearts to feel—" "Hush, hush," said his lordship; "you must not talk like that to the people, or you will offend them." "Well," Charles Dickens said, "what is the use of talking to people unless you appeal to their heads and hearts?" (Laughter.) Now, gentlemen, have not the events of this day and this convention appealed to our heads? (Cries of Yes.) And have not the proceedings of this day, which has culminated so gastronomically, appealed to our hearts? (Cries of Yes.) And will not this event be chronicled in the annals of our Boston Electric Club as one of the most eventful opportunities for entertaining so brilliant a company?

The chairman then said: "With profound affection and respect I give you as a toast Mr. J. Frank Morrison, our president. Three cheers were heartily given and Mr. Morrison responded.

MR. MORRISON: If you will accord to me for a few moments the courtesy which has so distinguished you during all these years while we have been associated together, I will endeavor to say a word or two that may be heard all over this room. It was most unexpected on my part to be called upon to say anything at this time. In this programme which I assisted in making for this evening, the next regular toast would have been to the electric lighting company, to whose bounty you are indebted for this very pleasant evening's entertainment. But favors sometimes go entirely beyond merits, and the favor has fallen upon me, through the kindly feeling which has existed during all these years between you and me. And so I am placed before those who have earned the honors of the evening. Once in a lifetime, perhaps a little oftener, comes an occasion of this kind with a sudden outburst of good fellowship that greets the gathering of men of science and men of work such as are gathered together in the goodly city of Boston to-day. Words of wisdom and words of welcome such as are rarely said to men gathered together as we are have greeted you to-night. You have here, in my judgment, the cream of the manhood of the electric business of the United States. One of the speakers in the National Electric Light Association to-day—I think Mr. Steuart, of Baltimore—said that on that floor was represented twenty-six of the States of the Union. What did that mean? Why, it meant that on the floor of the Parker House to-day stood a full representation from twenty-six States of this Union, showing the intelligence and the nerve and the pluck of the men who have stood at the front and made a new business a phenomenal success in the short period of eight or nine years. Mr. Steuart asked you to assist him in reorganizing the patent laws. And he asked you to go to the congressmen of your districts—you, gentlemen, who represent twenty-six States of this Union on the floor of this house to night—and give him the needed aid to clean out that nest of politicians, and put in their places men of science, who know and understand their business.

When this association struggled into birth in the city of Chicago, two years and a half ago, its most earnest advocates could have hardly looked forward to such a meeting as is present here at this sixth semi-annual meeting of the National Electric Light Association. A few men gathered together in the Grand Pacific Hotel at Chicago, and held themselves bound by the ordinary or extraordinary tie of intelligence such as is rarely possessed by any executive body. They have grown from the small handful of men to the three or four hundred men who have sat down here at this banquet of the Electric Club of Boston, under the auspices of the Thomson-Houston Electric Company in this beautiful place to-night. Are we not rewarded for our labors? Don't you feel proud to belong to the National Electric Light Association? Is there a man here who does not feel a thrill of glory such as soldiers sometimes feel when you look down these well-filled ranks to-night? Honor after honor has come to me, yet I will say that I am as ready to serve in the ranks of your association as in the office of president. I want, in the name of the National Electric Light Association, to return our thanks to the Thomson-Houston Company, and their coadjutors of the Electric Club of the City of Boston, so ably represented by their president and Mr. Slattery on this floor to-night. I hope that when I take my seat—I do not hope, I know—that you will accord to the

representative of that company, upon whom I am about to ask the toast-master to call, the same respectful hearing that you have given to me. Your affection for me is fully appreciated by me, and I ask you to continue that respectful attention, gentlemen.

The chairman, after mentioning the courtesies shown to him personally by Mr. Coffin, vice-president of the Thomson-Houston Company, called on that gentleman to respond. When Mr. Coffin rose to speak he was greated with a perfect storm of long-continued applause.

MR. COFFIN said: Mr. Chairman and the President of the National Electric Light Association, and Gentlemen of the Association. I thank you for the honor conferred upon me. I thank you in the name of the Thomson-Houston Company that so many of you, gentlemen, have come from so far, have weathered such torrid heats, have, in the persons of many of you, perhaps, conquered some prejudices; and all of you have, from first to last, shown us such great kindness, such constant attention, and such uniform courtesy on this occasion. It is not unusual at the close of a day, or at the close of life, to remember our blessings. To-night it is proper for members of this association, and for the members of the parent companies—to use a common term which I do not like, because it signifies that some are children, and we are, in fact, all of the same age, all men—it is not improper for us to remember our blessings. Among them are, first, membership in such a goodly body—an intelligent body, with a sprinkling of the scientific element, to which we can all pay tribute, if we cannot all understand it. We should be thankful that we are members of an association, are exponents and promoters, and representatives of that department of science and industry which attracts to it, and draws around it, so much of education and intelligence and manhood.

It is unusual, gentlemen, it is impossible, to find in all the fields of industry, in my opinion, anything which attracts so readily, so spontaneously, such a large percentage of our educated, earnest young men of convictions. With regard to the future of electric lighting, these men believe that if it is promoted, first, upon scientific—truly scientific—principles, and, secondly, upon business principles, it must succeed. It is impossible to look upon the faces of the gentlemen here assembled to-night and not be convinced that those of you who cannot be scientific electricians are earnest, and determined to promote your business upon a business and manly principle, with the intention to get the most that can be got legitimately out of the business. It is my pride, gentlemen, that young men leaving the colleges are flocking around the standard of this comparatively new industry. A gentleman has left the army, a gentleman whom I hoped to see here to-night, a lieutenant of fine and high promise, and turned his back upon all that his position promised him if he would remain in that profession, to take up the more promising work of electric lighting. We have here, I am happy to say, not in the electric light business directly, but in that which contributes to it, without which electric light is not possible, the carbon business, the son of an honored ex-President of the United States. These things will in themselves show the attraction of the new industry, of which we are proud to be the standard bearers. Our honored president also informs me that we have some half a dozen members of the United States navy, who, strange as it may seem, forsake the navy of the United States for the field of electric lighting. More strange than all, perhaps, we have several representatives here of that field of manufacture—that honored field—I am talking with perfect respect and admiration—that antiquated field of manufacture—that of the gas companies. (Laughter and cries of "Good.")

Now, gentlemen, I feel very much as though, if I talked to you longer, somebody would say to me, as a good old Methodist deacon said of a fellow Methodist deacon, in prayer-meeting—he said: "I wish Brother Jones was in hell." It created a sensation. But he insisted that he was honest in saying so; because if Brother Jones was in hell he would break up the whole institution in less than six weeks. (Laughter.) I am also reminded of a colored preacher, an earnest soul, who was once preaching about the sins of his parishioners, and who said that of all sinners the worst was the one who robbed his neighbor's hen roost. Some layman got up and said, "Hold on, there, brother; you are throwing a coldness over this meeting." Now I feel I shall throw a coldness over this meeting. I will say no more, except to return sincere and heartfelt thanks to these our hosts of the evening, whose grateful guests we are—the Boston Electric Club. I only regret that there are not here present representatives of the city of Boston, the bounty of which city we have been the grateful recipients of to-day. Hoping, gentlemen, to see you again soon, and hoping this convention may be presided over in the future by a gentleman of as great earnestness and as great executive ability as are possessed by the president whom it has been your good fortune to have in the past, I will bid you good night.

The chairman called for three cheers for Mr. Coffin and the Thomson-Houston Company, and three rousing cheers were given

Three cheers were called for in honor of the chairman of the evening, which Dr. Moses modestly acknowledged, and then again called out Mr. Slattery.

MR. SLATTERY: Dr. Moses, as usual, in the versatility and brilliancy of his ideas, has taken in almost the whole field, and has given expression to thoughts such as we are always pleased to listen to. While he was speaking a thought came to me, and I have got to give it. The manner in which we have alternated from intellectual pursuits during the carrying on of this convention, to social and bodily pleasures, and the agreeable manner in which we have been induced to visit one of the most prominent manufacturing electrical works in this country, or I believe in the world, will be ever memorable and eventful. I am more than gratified. I feel proud beyond expression at the courtesy that the Thomson-Houston Company has extended towards the Sun Company. Excuse me for expressing my sentiments in regard to a matter that concerns my company individually. It was given to me a few minutes ago from a reliable source. Mr. Coffin, who is the incarnation of business activity, and in combination with Prof. Thomson, whose scientific researches compel the respect of the whole world, have done so much to make the company with which they are connected successful and famous at Lynn to day, said: "This is the home of the Sun Company as well as of the Thomson-Houston Company. Let the Sun Company be represented as the Thomson-Houston Company is." Gentlemen, I consider that most magnanimous treatment. (Applause.) I was asked, when I stood up before, to give the definition of electricity. Now I feel that I should hesitate very greatly in the presence of our friend, Prof. Thomson, to give a definition of electricity, as I consider that his researches in that direction are infinitely superior to my own. Yet in the interests of science, and for the dissemination of true knowledge, I cannot withhold the information that I possess at the present moment. The definition of it is this: Water, being a parabolic fluid, is readily converted into a solid magnetized entity; when its coefficient has been received back in the reflected image of the spheroid, it undergoes a palezoic transmutation. Then it naturally seeks a vacuum, which, combined with alcoholic spinal meningitis, gives a geometrical crystallization which we denominate electricity. (Laughter.)

The chairman said there was "present a representative of the Monumental City, that city which set the example which you have so gloriously followed, of liberal and princely hospitality. I would call upon Arthur Steuart, of Baltimore, for a response."

MR. STEUART: Gentlemen, it is with the greatest diffidence that I get on my feet even under such an urgent request, after the eloquence that we have listened to. And I can only venture to say to you that we have been much more than eclipsed by the magnificent hospitality we have received here to-day. I am in your midst representing an interest that appears to be somewhat foreign to electric lighting. And yet I think if you will consider for a moment you will find that it comes home very close to the interest of every electric lighting man. My interest here is, of course, scientific and at the same time I am concerned with the general lighting business; but principally it is for the purpose of attempting to secure your cooperation in bringing about certain reforms in the patent system of this country. With 26 States of this Union represented in this association, and something over $300,000,000 invested in electric lighting or in collateral enterprises, and almost every dollar of that money invested under a patent of some kind, we are presented with inventors and applicants for patents who are going into the Patent Office, which has many points of virtue, but which, I am sorry to say, is full of error which we have power to correct.

I wish only to dwell upon one, which is the principal one. It is the great evil of political machination in that office. Suppose anybody were to make the attempt to run the National Electric Light Association, or the business represented in this assembly, by putting politicians into your stations and factories who knew no more about electricity than a pig does about Sunday? Would you expect your interests to be protected? I want to be guarded in what I say, because I have the very highest regard for so many of my friends who are in the Patent Office. But this evil is a great one. Now, with that state of things existing throughout the department, it is not surprising that every room in the office is from one to six months behind hand with its work, and that the *personnel* of the office is far from good in many respects. The committee that was appointed to consider this question reported to your body yesterday a bill which, if it should pass, would remedy many of these difficulties. That bill will be introduced into congress We call upon the members of this association to aid the committee in having that bill passed. See your representatives in congress, and make it a personal matter with each of them to urge the passage of this bill. We can have it made a law, and then we can feel that the money invested in electric lighting is safe.

THE CHAIRMAN: Gentlemen, I learn, by inquiry, that the train will not leave until 11 o'clock. (A voice, "We won't go home till morning.") You may be as sure as fate that it will leave at 11 o'clock. We have a limited time, and several gentlemen that we would like to hear from. I will introduce an official of the Thomson-Houston Company, one of its most vigorous and efficient officials, Mr. Barton, of Chicago.

MR. BARTON: Gentlemen, I cannot say that I am not disappointed in being called upon. It seems to me a little unkind to ask me to say anything on this occasion, after the able speech of our vice-president, Mr. Coffin. I have made a new discovery. I fully agree with Mr. Slattery that he is the incarnation of a business man, but I think he can aspire to something above and beyond anything that he has yet undertaken. He has in him a true vein of oratory. I was impressed also by the remarks made by Dr. Moses to his boys while we were in the reformatory. His remarks were full of promise and hope that if we came out good boys we should succeed and might aspire to anything. We have been told that only five per cent. of those who enter business succeed. And yet within a few short hours after we have all left the reformatory together, we find one of our number the incarnation of business enterprise, and the other the incarnation of scientific pursuits, while the rest of us are left out in the cold.

I feel like closing my remarks, which must necessarily be very brief, by adding to the thanks which Mr Coffin has extended to the Boston Electric Club for the entertainment which I have been privileged to enjoy to-day. Mr. Coffin has been full of the business, commencing to arrange some of the details of this, as he did, over a week ago, while I am enjoying a perfect picnic. This is the first convention that I have ever attended; but I don't think it will be the last.

The chairman then called for Mr. Walter C. Kerr.

MR. KERR: An opinion is usually based upon ideas, each of which is too small to stand alone, so that a number are grouped together and called an opinion. The most prominent that I have to-night is that the present is the biggest meeting of the National Electric Light Association that I have ever attended. It comprises probably the largest body of electricians that have ever got together upon this continent. It is a great question where it will all end. The National Electric Light Association which I first attended was a very small one. I have not seen much of these conventions but what I have seen convinces me that they are exceedingly useful.

I am reminded of a little story in connection with the possible growth of this association. In a certain banquet that was given in Paris by a celebrated French statesmen, a gentleman was called upon to respond to the toast of "America." He said the United States was bounded on the north by the North Pole, on the south by the South Pole, on the east by the rising sun and on the west by the setting sun. But another of our compatriots was dissatisfied with even such large dimensions as those, and he rose and said, "The United States is bounded on the north by the Aurora Borealis, on the south by the procession of the Equinoxes, on the east by Primeval Chaos, and on the west by the Day of Judgment."

THE CHAIRMAN: Gentlemen, we have still five minutes. In that time I would like to have some one express the utmost gratitude of this association in such terms as to justify the definition I once heard of gratitude, that it was a sense of favors to come. I will call upon Mr. Duncan, of Pittsburgh.

MR DUNCAN: When we have had a Moses to lead us through the land of Israel to-day, and a Slattery to lead us through the field of electric science, and a Kerr to lead us through that field bounded without space, I do not feel that I am able to reply to the toast which has been assigned to me. But I want to say on behalf of the gentlemen of the Electric Light Association that we feel the utmost gratitude, that we feel that it cannot be expressed in language; that there is no language adequate for the expression of our thanks to the Thomson Houston Company and to the Boston Electric Club for the hospitality extended to this association. I want to say, Mr. President and gentlemen, that if it shall be our privilege at some time in the future to entertain the association in the small village which I have the honor in some respects to represent—and I have been requested to speak on its behalf—we will endeavor in some feeble way to show our appreciation of the attention which we have received at your hands.

The CHAIRMAN of the evening was loudly called for, and said in response: Gentlemen, I have a watch which I am happy to say has a magnetic shield on it. I therefore keep it five minutes too fast. I don't want to monopolize the time that should be spent by others. I will therefore only tell a little anecdote. Once upon a time George the Fourth entertained at dinner a distinguished company. Sheridan sat on the king's right hand, and the Archbishop of Canterbury next to Sheridan. When the king had taken too much wine—too much of what we have been indulging in—he turned round and gave a cuff to Sheridan. Sheridan immediately slapped the archbishop, saying, "Pass it on." I want to pass this on. There is here a representative of that Gibraltar of civilization, the Kingdom of Great Britain. I will call upon Mr. Reckenzaun.

MR. RECKENZAUN—Gentlemen, as I am not a public speaker, so also I am not a native of Great Britain, although I am a subject. I was born in Austria. I will endeavor to express my sentiments so far as to say that I have never spent a more happy time in my life than I have spent to-day with the members of the Electric Light Association I shall always, as long as I live, remember this day, not only for the pleasure concerned, but also for the intellectual enlightenment that I have received. I will only add that when I return home I shall tell my confreres in Europe of the abounding hospitality and kindness that I have received in the United States to-day and yesterday, and all the time I have been in this country.

THE CHAIRMAN—Gentlemen, there is one toast that I will give you in one breath. Benjamin Franklin said that if there was anything in his composition that he was thankful for it was a little vanity. I say, let us give three cheers for the National Electric Light Association.

The cheers were given with great enthusiasm, and the banquet closed at 10.45 P. M., and the 11 o'clock special carried a happy company into the city of Boston.

A Few Convention and Banquet Stragglers.

The Boston press made very full and reliable reports of the convention.

As a toastmaster for an electric light banquet Dr. Moses is not to be surpassed.

The only disappointed man seen at the banquet was the one who couldn't eat more.

The great number of young men present and participating in the work of the convention was particularly noticeable.

With Messrs. Upton, Pratt and Glazier all in attendance, the Jarvis Engineering Company was most thoroughly represented at Boston.

The REVIEW desires to express its thanks to the courteous staff of *Modern Light and Heat*, to whom it is indebted for a number of considerate favors.

Mr. H. M. Cleveland, the first vice-president of the National Electric Light Association, now a Boston banker, was a welcome visitor during the sessions.

Recollections of the ride into Boston after the banquet will ever linger pleasantly in the minds of many, notably the good-looking gentlemen from Philadelphia.

Mr. James A. Pentz, of Philadelphia, representing the Southwark Foundry and Machine Company, is an able engine man and an enthusiast on the development of electric lighting.

The Hon. Ed. Maher's handsome form and features ably represented Albany's electric lights. Being a large purchaser, the carbon men were always glad to talk to the genial Albanyite.

Mr. Daniel Frank, the widely-known cigar importer, of 10 Post Office square, was among the Bostonians who assisted in making the visit of the electric light men most agreeable.

Mr. Geo. W. Davenport, who had charge of the Thomson-Houston's perfect exhibit, won many friends among the attendants, and is a capable, courteous representative of that great company.

When the convention swooped down on them with full force, the Parker House proprietors were almost paralyzed, but rallied bravely and provided for the convention needs in good style.

Quick work is the rule with electric light men In two hours after the convention adjourned the exhibits were packed, lights turned out, and the Parker House seemed deserted. The transformation was made with magical quickness.

The appointment of a Committee on Magnetism and its Effects on Timepieces was a good move on the part of the convention, and indicated the readiness of the electrical workers to fairly meet all questions that may come up. Dr. Lange, of Pittsburgh, the chairman of the committee, we understand,

has made a study of this branch, and will undoubtedly make a valuable report at the next meeting. There have been inventions of late looking towards the prevention and cure of the effects of magnetism on chronometers and timepieces generally, and their efficiency can now be very thoroughly ascertained.

Honors as to good looks were about evenly divided between Hon. Ed. Maher, of Albany, Mr. T. Carpenter Smith, of Pittsburgh, and Col. James English, of New Haven. This refers, of course, to visitors, for that well-known Adonis, Fred. A. Gilbert, of Boston, was barred.

Point of Pines will ever be remembered pleasantly by electric light men. In addition to the elaborate banquet, much of the youth and beauty of Boston was present at the popular hotel, and many of the electrical visitors (single men, of course) were seriously affected by glances from the bright eyes of the fair ladies who had never seen a real wide-awake electric light convention before.

Reunion of the "Old Timers."

The seventh annual reunion and convention of the "Old Time Telegraphers' Association" and the "United States Military Telegraph Corps" opened in Common Council Chamber, Philadelphia, August 18.

William B. Wilson, the Kensington freight agent of the Pennsylvania Railroad Company, delivered an address of welcome. He said: "It was my fortune to be made manager of the military telegraph office in the War Department early in the struggle, and it is therefore with confidence I speak of the organization and efficiency of the Military Telegraph Corps.

"On the 27th of April, 1861, on the order of Simon Cameron Secretary of War, David Strouse, Homer Bates, Sam Brown, and Dick O'Brien, four of the most reliable operators on the Pennsylvania Railroad Company's telegraph line, arrived in Washington and formed, under Thomas A. Scott, of Philadelphia the germ from which grew the best disciplined, the most wonderfully accurate, reliable and intelligent army telegraph corps ever known to the world." He said it was fitting that the reunion should be held in this city, because "it is worthy of note that, on that eventful voyage from Europe to America, in the ship Sully, in 1832, among the party of intelligent gentlemen with whom Prof. Morse discussed the topic of galvanism and electro-magnetism which led up to his great inventions, was a gentleman from Philadelphia—Mr. J. Francis Fisher—and further to note that among the corporators in the charter for the first telegraph company in the United States was the name of William M. Swain, of Philadelphia. Mr. Swain was the principal proprietor of the *Ledger*, and gave to the development of the telegraph those exact and unsentimental ideas of business with which he was characterized, and which brought success to the Magnetic Telegraph Company under his management."

He then spoke of "the memory of Morse, that able American, who, undaunted by disaster, unchecked by the frowns of patronage and power, nor overcome by the jealousies of science, perfected and put in successful operation the system of telegraphic communication, which not only challenges the world for its simplicity and power, but has been a potent agent in the rapid advancement of civilization."

Charles C. Hine, President of the Old Time Telegraphers' Association, responded, and an address, written by William R. Plum, President of the Military Telegraph Corps, was read.

David Brooks, of Philadelphia, delivered an address, in which he referred to some of the ways in which managers of telegraph companies make money and deal with their employes: He said "History repeats itself. There are now three competing telegraph companies in the field, and a war of rates going on. A war of rates is only a preliminary to a deal—a combination of some kind, and when that takes place the ranks will be thinned out and the rates raised. 'A merciful man is merciful to his beast,' but corporations have no souls. Governments are generally just to their employes—they do not turn every stone to make dividends.

"I see no remedy or way of preventing these occurrences in the future but to have the Government take control of the telegraphs and combine them with the post-office. It can be done with great advantage and economy. Every post-office could be made also the telegraph office. There is scarcely a telegraph manager in the country but who is also competent to be a postmaster Nor do I believe in the government building opposition lines or paying a mean price for those already in operation. The English government paid nearly double the market price of the stocks when it took in the telegraphs. I know of no class of people who would object to the government ownership and control except stock operators—they are greatly distressed at the thought of the government having so much patronage."

At the conclusion of Mr. Brooks' address the Old Time Telegraphers' Association held a business session. President Hine, in his opening address, spoke of the ancient modes of communication.

The following new members were elected: David R. Walker, Chief of the Electrical Bureau; William H. C. Hargreaves, Manager of the Associated Press; James L. Mingle, George W. Snyder and Joseph Beatty, of Philadelphia; J. E. Pettit, Chicago; J. F. Shorey, New York; C. H. Schemmerhorn, Plainfield, N. J.; Thomas A. Edison, Llewellyn Park, N. J.

David Brooks was unanimously elected president for the ensuing year. He was escorted to the chair and delivered an address in which he again advocated the government control and management of the telegraph.

Irving Dugen, of Louisville, Ky., was elected vice president, and William J. Dealy, of New York, was re-elected secretary and treasurer.

A message of greeting was ordered to be sent to Vice President Charles E. Taylor, of Frankfort, Ky., the originator of the association, who was absent, owing to illness.

In the afternoon the Military Telegraph Corps met in business session. In President Plum's absence, William B. Wilson presided. The president's annual address was submitted and read.

A vote of thanks was given Miss Sophia E. Easton, of Massachusetts, who was stated to have exerted herself to aid the corps in its endeavors to obtain recognition from congress.

President William R. Plum, Chicago: Vice President George C. Maynard, Washington, D. C., and Secretary and Treasurer James E. Pettit, Chicago, were unanimously re-elected.

It was decided to hold the next reunion of the two bodies in Chicago next year.

A banquet was served at the Union League, Thursday evening.

Large Sale of Arc Lights to the Scranton Gas Company.

A recent large sale of arc lights is worthy of special mention, and shows that gas companies are rapidly realizing the advantages of this illuminant. General Manager Powell, of the Brush-Swan Electric Company of New England, has just closed a contract with the Scranton (Pa.) Gas and Water Company, to consist of eight No. 8 Brush dynamos (furnishing 65 2,000 candle power lights each) with lamps, making a total sale of 520 arc lights. Three hundred of these lights are to be contracted to be running by the first day of October next. The Brush-Swan Company has already commenced work on the installation, and will see that the contract is carried out. This will necessitate the great works of the Brush Company of Cleveland, running night and day. The securing of this contract brings additional honors to General Manager Powell, who has been very successful in promoting the interests of the large company under his management.

The Brush-Swan Company is also installing a very large incandescent plant in the Electric Sugar Refinery of Brooklyn.

The Winsted Gas Light Company of Winsted, Conn., which installed a Brush plant a year and a half ago, have just increased their plant by a 45 arc light Brush dynamo with lamps. The Brush-Swan Company is doing a very large business with the gas companies of the East.

Dangers to Human Life from Electric Currents.

READ BEFORE THE CHICAGO ELECTRIC CLUB, AUGUST 23, 1887, BY F. B BADT, OF THE UNITED STATES ELECTRIC LIGHTING COMPANY.

The dangers from electric currents known up to about twenty-five years ago were those which pertained to discharges of atmospheric electricity (lightning), discharges of Leyden jars and secondary currents of large Rumkorff induction coils

Since the middle of this century the currents generated by powerful magneto or dynamo electric machines have caused their share of fatal accidents.

In order to understand the action of these different currents of electricity, we must first know of what kind of conductors the human body is built up. While to-day the total resistance of the human body is often assumed to be from ten thousand to twenty thousand ohms, scientists who have made this a subject of experiment agree that it is greatly overestimated.

W. H. Stone, in a paper read before the British Association, published in *Nature*, mentions examples of the conflicting and contradictory statements made by different authorities, as to the electrical resistance of the human body. He believes it to be enormously overestimated, being given all the way from 13,000 to 2,875 ohms and less. The task of measuring the resistance of the human body is met by three obstacles: 1. the difficulty of making good contact through the skin of living man; 2, limitation of amount of current by pain, and the tetanic condition of the muscles, which is the effect of rapidly opening and closing strong currents; and 3, that the human body is an easy electrolyte, furnishing currents of polarization almost immediately.

Stone gives two ways for making contact: immersing the hands or the feet in salt water in contact with an electrode of amalgamated lead or zinc; or by wrapping the limbs with thin sheet lead. Stone found as the result of his experiments that the average resistance from foot to foot would be about 936 ohms, and from foot to hand, 1 027 to 1,320 ohms, according to the height of the man. Other authorities think, however, that increase in stature is balanced by cross-section, thus making the average resistance about the same.

From this it will be very easily seen that currents even of very low E.M.F. will be unbearable to man, if proper contacts are provided. The fact that this latter will rarely be the case, explains how people have withstood currents of hundreds of volts without injury.

The best conductor in the human body is the blood; next to this the tissues. If we therefore read in the ELECTRICAL REVIEW of July 9th, 1887, that a man in Texas was struck by lightning in the back of the neck, it cannot be surprising that both his shoulder bones were found broken. The lightning, in its passage to the ground through his body, left the better conductors uninjured, but shattered the conductors of higher resistance which lay in its route.

While we find this wide difference of opinion relative to the resistance of the human body, equally great discrepancies are found in estimates of the intensity of lightning discharges.

All authorities agree that the E M.F. of a flash of lightning is probably many million volts; they most decidedly disagree as to the intensity of the current. While some authorities assume that the current of the most powerful flash of lightning is but a small fraction of an ampere, others believe it to be many thousand amperes; and one scientific gentleman even calculated it at fourteen million amperes. Some claim that lightning though it be a current of electricity, does not obey the laws of Ohm, while others think it does. Whatever the truth may be, it probably lies between the two opinions, and flashes of lightning may be currents of only a fraction of an ampere or upwards to hundreds of amperes.

For the benefit of those gentlemen who are not well versed in electrical units, I will add this: The ampere is the unit of strength or rate of flow of the current. One ampere is the rate of flow per second caused by the E.M.F. of one volt, through the unit of resistance of one ohm.

The quantity of electricity obtained by one ampere after one second is one coulomb, or one coulomb will give one ampere after one second. Just as we would speak of water running through a pipe at the rate of one gallon per second, meaning that one gallon of water will pass a given point in one second. The quantity of water obtained at this rate after one second will be one gallon; after two seconds, two gallons; after one-half second, one-half gallon. So that at a rate of one ampere per second in ten seconds we would have accumulated ten coulombs; or, if the rate were ten amperes per second, we would accumulate ten coulombs in one second.

Now let us suppose the rate of the flow of lightning be 10 000 amperes, and the duration—as often estimated—one-twenty thousandth ($\frac{1}{20\,000}$) part of a second; the quantity of electricity in such a discharge would amount to only $\frac{10000}{20000} = \frac{1}{2}$ coulomb. I suppose this is what is meant by many authors when they speak of the very small "current" of electricity in lightning. The rate of flow or the current strength may be enormous, and still the quantity, depending upon the duration of the discharge may be small.

The difference in mechanical effects between that produced by a quantity of electricity discharged slowly through a considerable lapse of time, and that resulting from discharging a minute quantity in the infinitesimal part of one second, may, perhaps, be fairly illustrated by rolling a heavy cannon ball slowly over the floor, and firing a tallow candle from a musket. The heavier missile will stop at an obstruction like a door, while the candle will pierce it like a bullet.

The majority of people struck by lightning in the open air appear to receive the shock in the head, after which it passes through the body and out at the feet. In some cases the arteries through the body have been broken and bled freely. In others the skin has been burned, and also the hair; deep furrows are sometimes dug in the muscles and not a drop of blood shed. Usually there are no external signs of injury, or, at most, but faint marks, such as redness, or swelling of the skin, resulting from the discharge. Persons having afflictions of certain special senses have been entirely cured. Individuals have been deprived of memory, while others have been deprived of all movements and control of muscles, while their intellectual faculties remained in their normal condition. Death does not always ensue immediately after the shock, despite appearances. Persons have lain in a passive state for hours, and in some cases several days, still alive, but showing no signs of life. Early putrefaction is a reasonable indication, as bodies decay soon after death from an electrical current. It is for this reason that autopsies, which, as a general rule, are made several hours after death, are of little value. It is very difficult to determine whether the changes found are produced by the electric current, or are simply post-mortem changes due to decomposition. External indications, such as burns, discolorations and the like, are due to electrolysis where the soft tissues have came in contact with the conductors, or are caused by the spark, when making or breaking the circuit. The extent of such injuries, of course, depends entirely upon the E.M.F., and the length of time the current passes through those parts.

Death may occur in three different ways: 1. By sudden contraction of the muscles and stoppage of the heart's action—as in a surgical shock—and interference with the lung movements. Both caused by disturbances of the pneumogastric nerve. 2. By paralysis of the cerebro-spinal system; by paralyzing the nervous system it loses its balancing power over the vaso-motor nervous system, producing tetanic contraction of the heart and arterioles, causing instant death. 3. By the electrolytic action of the current.

Monsieur A. d'Arsonval recently made

some very interesting experiments as to the physiological effects of different sources of electricity. These experiments were published in No. 16, April, 1887, of *La Lumiere Electrique*, and were made with the following apparatus:

1. A static Holtz machine, charging a battery of Leyden jars.
2. A galvanic battery of 420 volts.
3. Gramme continuous current machines.
4. Gramme alternating current machines.
5. Induction coils, with and without condensers.

The results of M. d'Arsonval's experiments are given in this resume: "Death by electricity may occur in two ways. First, by direct action (disruptive effects of the discharge, acting mechanically, so as to change the tissues). Secondly, by reflex, or indirect action—action on the nerve centers, which may be irritated in many ways. This simple distinction, which is the result of a minute observation of facts, is of practical value in this: that, in the first case, death is sure; while, in the second, experiment has demonstrated that the individual can very often be restored to life by artificial respiration, if practiced immediately after the accident.

"The dangers presented to me by the different sources of electricity may be summed up in a few words:

"1. The static discharge is only fatal when received in the immediate vicinity of the base of the brain, or head of the vertebral column, and when the energy of the blow is at least equal to 3 kilogrammeters. Under these conditions the different tissues (nerves, blood, muscles, etc.), struck by the localized disharge, will lose their physiological properties, without any hope of cure. If the discharge has not energy enough to alter these nerve centers mechanically, it will produce the phenomena of stopping the respiration, stopping the heart's action, accumulate air inside the parenchyma of the lungs, paralysis, etc.—results which M. Brown-Sequard has obtained by irritating these regions with different excitants.

2. "With a battery of 420 volts we can cause death only by frequent and long continued interruptions of the current. This death is due to the tetanic condition, indirectly caused by the current, rather than by the direct action of electricity."

"3. The continuous current Gramme dynamo is only dangerous as claimed by M. d'Arsonval on account of its extra current, when the circuit is broken. He has been able to verify the fact that compound-wound dynamos are less dangerous in their discharges of the extra current than series wound dynamos. The extra current of a series dynamo generating 20 amperes and 45 volts killed a guinea pig, while the extra current of a compound dynamo, generating 25 amperes and 110 volts had no bad effect. This difference explains itself when we consider that one part of the field is wound in derivation and shunts the greater part of the extra current. I will state here that M. d'Arvonsal has omitted the clean shunt-wound dynamo which is extensively used in the United States, mostly for incandescent lighting, but by some companies also for arc lighting. One of the companies using a shunt dynamo for arc lighting has never had a fatal accident on their circuits, while the same cannot be said for companies using series dynamos. The explanation hithorto given was founded on the fact that the series dynamos used in these cases, generated a higher E.M.F. than the shunt dynamos. This explanation, however, is not satisfactory, as there are similar cases on record where 800 volts of series-wound dynamos have proved fatal, while 1,200 volts of shunt dynamos have proved harmless. The above explanation of M. d'Arsonval throws light on these facts, while the extra current of a series dynamo will find but one route (through the human body) the greater portion of the extra current of the shunt dynamo will pass through the derived circuit of the field.

"4. An alternating current Gramme dynamo does not cause death unless there is present a mean difference of potential of over 120 volts.

"5. An extra current set up by an interrupted current passing around an electro magnet, is more dangerous than that from an induction coil, especially if the latter should be connected with a condenser."

The danger of a discharge depends more on the duration than either the E.M.F. or the intensity of the current. The same is true for alternating currents from which the danger is proportioned to the number of reversals per unit of time.

Prof. Du Bois Reymond, the Berlin scientist, expresses this in the following law:

"It is not the absolute density value of the current during each instant when the motor nerve answers by contraction, but the change of this value from one instant to another. The excitation to motion increases in proportion to the rapidity of uniform impulses, or to increased density in unit of time"

In concluding his paper, M. d'Arsonval states that under the ordinary circumstances of commercial use the current kills by reflex action. In most cases he has succeeded in restoring life to animals shocked by electric currents by practicing artificial respiration. Hence, if in any electrical establishment a man should receive a severe shock, artificial respiration should be resorted to at once. The currents so far used in commercial industry in most cases kill by stopping the respiration. Artificial respiration, by preventing asphyxia, will reinstate natural respiration It may not be out of place here to mention a few methods of practicing artificial respiration:

1. M. Brown-Sequard states that for several years one peculiar mode of excitation to re-establish respiration in cases as named above has been used in the College of France. It consists in the application of the Faradic current on both sides of the larynx under superficial incisions of the skin.

2. Artificial respiration, as usually practiced, should consist in laying the person on his back, pulling the tongue forward, and extending the arms over the head; then compress the chest slowly and regularly, at the rate of about sixteen times per minute.

Physicians recommend that inasmuch as the current paralyzes the cerebro-spinal system, stimulants should be used, such as ammonia, alcohol, etc., for the purpose of arousing the cerebro-spinal system to action. And again: Use a one per cent. solution of nitro-glycerine in two-drop doses, dropped on the tongue. This is immediately absorbed, and is one of the most powerful heart stimulants known to the medical profession.

Death from a heavy shock must be painless. It is estimated by psychologists that it takes the brain one-tenth of a second to collect itself and recognize the impression sent to it over the nerves, before any act of consciousness takes place. Noting the rapidity of an electrical discharge, there can be no consciousness of such a shock.

I will give a few extracts from another paper of M. d'Arsonval, which I thought very interesting:

"All physiologists agree that the energy of an electric excitation depends less on the intensity of the current than on the velocity of the fall of potential ('Rapidité de chute de potential!'), and the frequency of the excitations. This fact may be expressed in the following axioms:

"*Axiom* 1. A battery and a dynamo, each delivering current in a straight circuit—both currents of the same E.M.F. and intensity, do not offer the same dangers.

"If either circuit should be broken the battery circuit will give a hardly perceptible shock, while the shock from the dynamo may prove fatal. The danger comes alone from self-induction, or the force of the extra current. This force will depend on the construction and size of the dynamo, from whence we deduce it.

"*Axiom* 2. Two dynamos delivering currents of the same E.M.F. and intensity into similar circuits may prove more or less dangerous, as their coefficients of self-induction, and hence their extra-currents may differ greatly.

"*Axiom* 3. The same current, not dangerous in one circuit, may be so in another circuit."

That is, it is sufficient to give the current a chance for self-induction by any means whatever, to make it dangerous. M. d'Arsonval has verified these axioms by experiment. He operated with currents from two to 20 volts, and from one to 50 amperes. Even with these comparatively feeble currents he succeeded in killing guinea pigs. We see, therefore, if we would avoid all dangers from the employment of electrical currents there is absolutely no safety, save in letting electricity severely alone.

What shall we do to protect ourselves? Connect for instance, between the binding posts of a dynamo, a series of accumulator battery plates in acidulated water, in number sufficient so that their E.M.F. of polarization is higher than the maximum E.M.F. of the dynamo. This shunt cannot be passed by the direct current, while the extra current will traverse it easily, and not injure the human body which may be in the circuit at the moment it is broken. The same protection may be obtained in many other ways, and it should be law to have each dynamo or battery (primary or secondary) of a higher E.M.F. than 150 volts, provided with a mouse trap apparatus, to catch the extra current, or strangle it at its birth.

In order to prepare this paper, I have read up a considerable number of cases of people struck by lightning—in fact, the medical journals are full of them. This is not surprising, as death from lightning is not by any means a rare occurrence. In France alone, from 1835 to 1863, 6,714 persons were struck by lightning. 2,238 of this number were killed. These are very interesting statistical data, but unfortunately my confidence in them was a little shaken when, intending to express the number of deaths in per cent. of the total number struck, I found it to be just 33⅓ per cent. Three times 2,238 is exactly 6,714. I presume the writer found a statement of the number of people struck, which assumed that about one-third of this number were killed; not satisfied with this, but desiring to be mathematically correct, he figured it down to exactly 2.238. What a blessing there was not a fraction.

I will not weary you by reading many of these very interesting cases, but conclude with the account of two accidents from arc light currents as the most instructive to this assembly.

1st: "Stunning and burn by an electric lamp by Prof. George Buchanan, Prof. Clinical Surgery, Glasgow University, Feb. 13th, 1886." I quote:

"Injuries from electric lamps are becoming not infrequent In most of the cases related, death has been instantaneous. In a case reported January 22d, as occurring at Liverpool, the man was stunned and remained unconscious for a time, and on recovering was found to be quite blind." The case here related is very curious as to its causation and effect.

"Wm C——, aged 44, a workman in Clydebank building yard, was engaged at a crane, on Nov. 19, 1885. At the extremity of the wooden area of the crane was an iron pulley over which an endless chain hung, for raising weights. The man had occasion to pull at the chain, and while so doing, an electric lamp, which was suspended above, by some mischance was lowered till it touched the iron pulley. The lamp was one of the arc kind. The instant this occurred, the man felt a shock pass through him, became 'doubled up,' and lost consciousness; but he did not fall to the ground, being held by the chain, which his hands firmly and involuntarily grasped. Some three or four minutes elapsed before the electric current was cut off at the machine, when the man dropped down on the ground stunned. He was taken to the Western Infirmary about an hour afterward, by which time he had recovered consciousness, and could give a distinct account of what had happened. The injuries received were not very severe. There was a vesication on the palm of his hand, where it held the chain; also one on the side of his neck, which rested against the chain during his pulling it down. On the side of his right foot in front, where the chief weight of his body rested in the act of pulling, was a spot about two inches square, where the tissues were completely charred by the heat of the current passing into the ground. There were no nails in the boots, and there was no perceptible evidence of heat on them, but the sole of the stocking was charred, opposite the charred part of his foot.

"Sir Wm. Thomson, who questioned the man after his recovery, explains that the moist foot of the stocking must have acted as the medium of conduction between the man's body and the ground, and so determined the seat of the burn.

"The symptoms complained of were not very severe. They consisted of a slight amount of general shock, a feeling of heat in the abdomen and chest, and dimness of vision, all of which passed off in twenty-four hours. The wounds were treated in the ordinary way. A large slough, separated from the sole of the foot, followed by rapid granulation and cicatrization, and the man was dismissed in about six weeks.

"Sir Wm. Thomson suggests that if any of the bystanders had taken the man by the clothes and drawn his feet from contact with the ground, or had thrust a bit of dry clothing of any kind under his foot, the contact would have been broken, and the hand relieved from its grasp on the chain. The wonder is that an electric current, powerful enough to char the thick integument of the sole of the foot, passing through the man, did not produce any internal mischief." Resisting electrical shocks. From the Boston *Medical and Surgical Journal*, Nov. 26, 1885.

"Dr. A. L. Hummel recounts some curious cases of recovery from electric shocks, which ought, according to all ideas upon the subject, to have proved fatal. Two of them are given in *Popular Science News*.

"One is that of an employe of an electric light company, who, while still grasping the wire in his left hand, cut it with a pair of pliers held in the right. The current was at once established through his body, and he was held to the wire at the top of a 30-foot pole for three minutes at least, by which time a ladder had been procured, and he was released by a fellow-workman. During this time a current of 3,000 volts, or sufficient to run 50 arc lamps of 2,000 candle power, had apparently passed through his body; yet he was able to reach the pavement, with slight assistance, suffered little or no constitutional disturbance, save a slight rise in temperature, and was not confined to his bed. His punishment was limited to the charring of three fingers on his left, and a small, but deeply burnt hole in the palm of the right hand. The only treatment was that applied for simple burns.

"Another case was afforded by one of the workmen of the Bell Telephone Company, who, having climbed a pole belonging to an electric light company, in order to carry a wire over it, grasped the tie wire of the positive line with one hand, and that of the negative line with the other. Here he was held until an assistant ran five squares to the electric light station, when the current was broken and he was released. A rope had been attached to him, and passed over the arm of the pole. This was held by another man, and he was prevented from falling. Though unconscious for a while, he soon rallied, but his pulse never exceeded 86, nor his temperature 101. The thumb of the left hand was burned nearly off, as were also the index and middle fingers of the right hand. These were all amputated."

NOTE—I have omitted the name of the electric light company in the above cases, for the reason that all these interesting accidents happened on the lines of one system, and I do not want it to appear that I had picked out this one company purposely.

—— Notwithstanding the high rate of Canadian duties upon American goods and machinery, considerable activity is now manifested throughout Canada in electric light apparatus. The American Electric Manufacturing Company are shipping considerable quantities of apparatus into the Dominion. Mr. A. R. Williams, of Toronto, Ont., has sold a number of plants, and has just ordered a 25 light dynamo machine and lamps from the American Company to use as an exhibit in the coming Provincial Exhibition to be held in Toronto next month.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING AUG 16, 1887.

369,190 Art of converting chemical energy into electrical energy. 369,191 Galvanic cell; William E. Case, Auburn, N. Y.

368,195, Electrical piano; George F. Dieckmann, New York, N. Y., assignor of one-half to Paul Gmehlin, same place.

368,196 Apparatus for ventilating ships' holds: Geo. S. Dodman, Liverpool, county of Lancaster, England.

368,217 Printing telegraph; Jacob H. Linville, Philadelphia, Pa.

368,221 Circuit changer; Charles W. McDaniel, Kansas City, Mo.

368,265 Electro-mechanical brake; Granville T. Woods, Cincinnati, Ohio, assignor to the Woods Electric Company, same place.

368,315 Means for dissipating electricity for printing machines; Lewis E. Bathrick, Brooklyn, N. Y.

368,321 Battery connection for electric conductors; Patrick Bowe, Jersey City, N. J.

368,336 Burglar alarm; Albert E. Hathaway, Needham, Mass.

368,342 Telegraph key; David Kunhardt, Aachen, Prussia, Germany.

368,405 and 368,406 Electric rock drill; Harry N. Marvin, Syracuse, N. Y.

368,411 Synchronal motor for electrical typewriters; James F. McLaughlin, Philadelphia, Pa.

368,450 Telegraphic transmitter; Wieland H. Bloom, Galt, Ill.

368,541 Printing telegraph; Henry Mahnken, Brooklyn, assignor to the Commercial Telegram Company, New York, N. Y.

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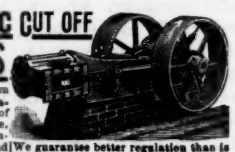

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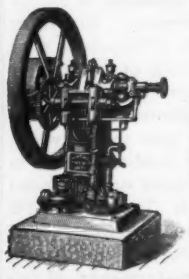

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